

A Semimonthly Technical Newspaper

Metallurgical & Chemical Engineering

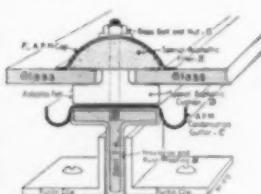
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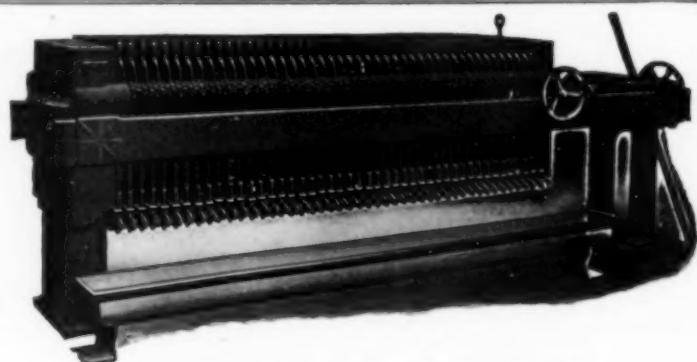
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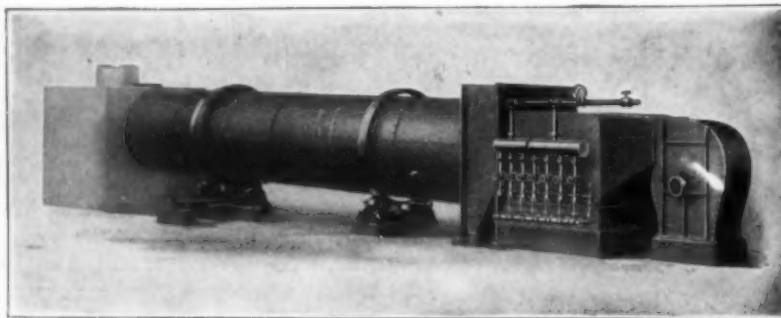
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On the Progress of the War

One of the most popular "indoor sports" of the season seems to be criticizing the activities, or lack of activities, of some particular governmental department, spouting out virtuous indignation at the lack of co-ordination exhibited generally, and predicting disaster for our cause from procrastination and diffusion of energy. And indeed, it seems at times as though the man on the street has ample grounds for complaint. First, he observes certain elected legislators practising law in the Senate, obstructing essential legislation, creating boards—long, narrow and wooden—for positions needing centralized authority in the hands of one energetic administrator; investigating suspiciously and even vilifying the personality of any man or committee who really gets things done without asking for advice, all in a manner highly pleasing to the Imperial German Government. Next he observes interminable squabbles between Denman, lawyer, and Goethals, canal builder, on the proper way to build up a merchant fleet, they meanwhile doggedly forgetting that they are connected with an *Emergency Fleet Corporation*. And as a final straw he observes the spectacle of one cabinet member branding as exorbitant and impossible a coal-price tentatively fixed at a conference between a brother cabinet member and a large number of coal producers, even after a third member of the cabinet had told the conference to be careful not to do anything in restraint of trade, in effect warning them against doing anything and yet saying that something must be done.

This lack of co-ordination is only natural. Happily, the American democracy has not the highly centralized ("efficient," if you will) legislative, administrative and judicial branches of the German "democracy." Nor have we for years been bending every energy, adapting every industry, training every son, co-ordinating every activity, suborning all education toward "der Tag," when we at last would smash our way into our place in the sun. Our Government was built on the practices, ideas, and ideals of peace, and such an intricate structure cannot face about sharply to the pursuit of war without sundry creaking in the joints, clattering of furniture, and general dislocation.

We would therefore counsel patience. Put yourself in his place. Most of the troubles appear to arise from a lack of fixed, definite, and coherent war policy. The change in function of our various governmental departments is no more radical than these: Suppose that a sugar expert should suddenly be transported to the center of a powder factory, or that a cyanide man be

given charge of an electrical steel-furnace, each with the admonition that he take hold, make a record production, and, above all, get busy *quick*. Would there not be an extreme liability for diverse and sundry flashes, a falling off of the power factor, accompanied by more or less short-circuiting and various other fireworks?

Unless the man were absolutely worthless the best he could do would be to call in various disinterested experts, familiar with those details strange to him, and accept and act upon their advice. We may be thankful for the assurance that notwithstanding the suspicions of certain Senators, this is being done to an extent before undreamed of; red tape and tradition is being thrown aside in large volume, and replaced by common sense and progress. The informed engineer even sees reassuring evidence of co-ordination between governmental official and technical advisers in Secretary Baker's recent statement that only \$4,000,000 of the \$20,000,000 available for a nitrate plant would be expended at this time. The Government is apparently hesitating before it embarks upon the development of a water power nitrate-plant, and in this is wisely following expert opinion given originally by the Committee on Public Relations of the American Electrochemical Society just a year ago. Doubtless, the Department is wisely keeping the precise plans very secret, and it is impossible to form an opinion as to the process or processes it intends to utilize. It is safe to say, however, that if some power-consuming process be adopted, there will be means for securing the necessary electricity instantly from systems at present constructed and operating without the necessity of delaying production until a large dam and hydro-electric station can be installed, a matter taking at least a year of the speediest construction. Here again there seems but little justification for the fulminations of the daily press upon the lack of enterprise in essential preparations.

Finally, one should not forget that a censorship prevents the publication of news about the *accomplishments* of a nation at war; only the obverse and darker side of the picture is held up for public inspection. We therefore recommend a little stabilizing trip for the man who looks about him and sees no evidence of war-activity, when he gets to seeing and purveying only gloom. Let him run over to one of the training camps for the officers' reserve, or to a concentration camp for the new army, or to an aviation school. Even if a watchful sentry prevents him from getting very close to the hive of activity, still he can absorb a different and saner viewpoint by contact around the edges.

Regulating Steel Prices

Everyone knows, first, that there is a controversy between the authorities at Washington and the steel manufacturers over the price the Government should pay for such steel as it needs to prosecute the war, and second, that there is a disposition, or a desire, in Washington to fix maximum limits for the price of steel that may be sold to private consumers. Beyond this nobody seems

to know anything. The parties are maneuvering for position and will not commit themselves to anything specific. If the public undertakes to draw inferences as to their real intentions, a hopeless puzzle results. Washington does nothing but wield the big stick it picked up at the beginning of the war: "Cost plus 10 per cent!" while the steel makers allow it to be assumed that they are contending for a price in relation to the present market, whereas in fact there is no regular market in existence.

Neither party is serious. It is simply maneuvering. Let us see what "cost plus 10 per cent" would mean. Using a weighted average of the finished steel products, the lowest selling price in the past 15 years was about 1.42 cents per pound, in December, 1914. There were practically no profits then, but on a full output there would have been some profit. Then, assuming 1.30 cents as the average cost, 10 per cent profit on an output of 31,000,000 gross tons a year would net \$90,000,000 for the American steel industry. In the United States Steel Corporation's four poorest years in its 16 years' history it averaged about that amount, with an output barely more than one-fourth as great. The steel industry cannot possibly turn its capital fast enough, having such a large investment per ton of output.

Now if there is a market at present, what is it but the price at which one can buy for delivery not longer than a few months hence? That would be $4\frac{1}{2}$ cents or more for bars and shapes, about ten cents for plates, perhaps nine cents for sheets, and various other prices beyond all market precedent, even the precedent of a few months ago. The weighted average already used would work out not less than six cents per pound of steel. Even if the cost of production has increased 50 per cent, which of course it has not, the profit on a year's output would be two and three-quarter billion dollars, or an amount quite close to the total capitalization of the industry.

The three heavy products in the steel industry are bars, shapes and plates. The average market price in the ten years 1905 to 1914 inclusive was: Bars, 1.385c.; shapes, 1.472c.; plates, 1.456c., an average of 1.44c. Profits must have been fairly satisfactory as dividends were paid and new plants built from earnings. Chairman Denman of the Shipping Board set 2.50c. as the price to be paid for bars, plates and shapes for the merchant ships the Emergency Fleet Corporation is to build. If 1.44c. were the production cost, the profit at 2.50 cents would be such that, if applied to the entire steel output, the total would be about \$730,000,000, or more than double the Steel Corporation's earnings last year—those earnings having been more than double the earnings in any previous year. In passing, it might be noted that the Steel Corporation produces approximately one-half the country's steel output.

One reason for the rejection of Chairman Denman's proposed prices was doubtless that if they were agreed upon an effort might have followed to force the prices down farther. Another reason, of course, was that plates, the commodity chiefly needed, were put at the

same level as bars and shapes, whereas market conditions have long established a much higher price for plates than for the other commodities. Doubtless another reason was the danger that if such prices were arranged for Government steel, there might be another step; to fix prices for all buyers at the Government level.

Thus there is no indication that the two parties are defining their position so as to reach a common ground. The measure should be the amount of profit it is fair that steel producers should make in times like these. Should the profits be larger or smaller than those of 1916? In that year they were almost three times the average profits of 1912-13-14, which figure is taken in the Senate law as being the basis for computing "excess profits." If 1916 be taken as a standard from which to make a departure, it might then be determined whether or not extra profits should be allowed sufficient to cover the excess profits tax, leaving the steel producers with the same net earnings as before. To the average prices realized in 1916 there could be added an amount equal to the increase in cost of production, not especially difficult to ascertain. The result would be a schedule of prices applicable both to the Government and to private consumers, in accordance with the "one price to all" doctrine enunciated by President Wilson in his statement made public July 12.

Wanted:—An Industrial Army

The thoughtful observer is depressed by the continual news of strikes, large and small, which appears from all sides. Few of them involve a considerable body of men actually on strike, but in their influence on allied and subsequent manufacturing processes it is quite probable that they are materially affecting the volume of some much-needed output. The refusal of a few dozen electricians or hoisting engineers to continue work in some mining district could very easily paralyze production—not a miner could work, if he would. Immediately smelter receipts will be curtailed, causing partial or complete shutdown, which in turn is reflected in a diminishing refinery output. Only one or two weeks ago a strike among machinists in the shipbuilding yards near New York threatened a complete shutdown of this most essential construction.

It is not a question of the laborer lacking patriotism. The patriotism of the American citizen, be he workman or employer, is beyond suspicion; unfortunately, however, he fails to realize the full consequence of his attitude. We are all heartily in favor of economy, as long as it doesn't interfere with our comfort or our business. All of the manufacturers are pointing with pride to their willingness to co-operate with the Government as to price and production, while Wall Street trembles to a falling market. The press is anxious to raise a large part of the war budget by taxation as long as the postal rates are not increased. The American farmer is glad to produce wheat enough to feed the world at a minimum price of two dollars a bushel. The

American unionist will cooperate with the Government in a closed shop.

We have yet only dimly glimpsed what this war is going to mean to each of us; we have not yet a shadow of the profound effect it will have on our public and private life, habits, and character. For compulsion, that ugly thing, has come into our state, hand in hand with his uglier master, war. Martial law is supplanting civil law. A conscript replaces a volunteer. Price-fixing supersedes the law of supply and demand. Commandeering guarantees adequate output.

But how can even a commandeered factory produce munitions without workmen? And who is to certify that machinist Stillson will take orders from Foreman Trott any more willingly to-morrow when Superintendent Brisk receives directions from under-secretary Tape than to-day when Brisk is in touch with managing-director Bond? He is still working in the same old shop, at the same old machine, turning out the same old product, cussed by the same old bosses, getting the same old pay envelope, and listening to the same old agitators.

It seems a pity that the Government is not to utilize the key to the labor situation, which is already in its hands, ready for adaption, in the draft law. Men with families will not be called into military service, principally because it is more economical to leave them behind to take care of their dependents. But simply because such a man is exempt from combatant duty, he should by no means be exempt from *service*. How simple it would be to enlist him into an industrial army—divisions of farmers, blacksmiths, carpenters, miners, trades and occupations of all sorts, organized for *service*, enlisted in our cause, ready to go where they are needed, and to work with their hands and brains in turning out the munitions so essential to the war.

Such a mobile industrial army would have a profound moral as well as material effect at the first hint of labor trouble. Unanimity would be impossible because a certain proportion of the men would already be drafted into the industrial army. They *could* not quit, short of treason. Any other man of divided allegiance would be assured that when he left work, there would quickly appear soldiers of the United States of America, willing and ready to do their bit to help win the war by maintaining production.

Commandeering of both plants and labor is as essential to the conduct of our war as is conscription of the army, and as inevitable. It might appear difficult, if not impossible, to decide such questions as, "What industries are essential?", "What particular portions of these industries should be commandeered?", "What trades within these factories should be fool proof?", "Where and when shall we move our 'soldiers of peace'?" The determination of such matters will sooner or later be placed in the hands of a well-organized Department of Munitions and Production—why not do it sooner?

The organization of this industrial army would be comparatively simple. The mechanism of its selection is already in our hands. Why not use it?

Readers' Views and Comments

Sampling vs. Correct Analytical Results

To the Editor of Metallurgical & Chemical Engineering

Analytical chemists in U. S. A. have lately been much agitated over the discovery that certain widely-advertised chemicals used for laboratory purposes are not so pure as their labels indicate, and a discussion upon the value of "analyzed chemicals" has taken place in the press, and also before some sections of the American Chemical Society. This discussion proves once again that the sampling of any commercial product is quite as important as the analysis of the sample when obtained, and that more supervision ought to be given to the preliminary work of selecting and preparing the sample.

As a chemist of considerable experience in manufacturing work and with a knowledge of the conditions that usually obtain when samples of bulk-deliveries are taken for analysis, the writer can state that in nine cases out of ten, this work is entrusted to youths or men with insufficient training and knowledge for the work. Very many of the disputes that arise between the sellers and buyers regarding the purity or strength of the commodities sold, are due in fact not so much to the inaccuracy of the analytical methods, as to inaccurate sampling.

The widely prevalent idea that any man or youth provided with the necessary tackle can be trusted to produce a fair and accurate sample of a manufactured chemical product without any supervision, must be eradicated before progress toward greater accuracy can be attained.

There are instances no doubt, in which the chemist himself cannot spare the time necessary for constant supervision of this work, as in the case of large purchases of ores, shipped by sea or rail in bulk. When this is the case, the oversight of the sampling must naturally be delegated to some competent and intelligent man, who has been well-trained in the theory and practice of sampling, by the chemist whose place he is to take. Since attempts to bribe samplers are by no means uncommon, a man of strong character and stiff moral backbone should be selected for the job.

As regards the common faults of sampling, there are three conditions which must be observed, if a fair sample of any commodity is to be obtained:

(1) The original sample taken must be large enough to represent all portions of the bulk, and a fair proportion between large and smalls must be maintained.

(2) The sample must be reduced by repeated crushings, mixings, and quarterings, to the small quantity required for the actual test.

(3) In order to continue the crushings and quarterings up to the required degree of fineness, it is necessary to dry the sample at some intermediate stage. A wet or damp sample cannot be ground to pass through a 60-mesh brass wire sieve used for the final stage of sampling.

Conditions (1) and (3) are those which are most often neglected in practice by those entrusted with the sampling operation. The first calls for the exercise of careful judgment and considerable intelligence on the

part of the sampler, while the third demands great patience, especially with ores and other hard materials. The crushing and passing through the sieve of the last portion of the sample is the most important part of the sampler's work, since in many cases the impurity is harder than the pure substance, and to throw these last fractions of the original sample away, because they are difficult to grind, is a fatal error.

In conclusion, it may be stated that the need for some greater degree of uniformity in sampling methods is urgent. Chemists as a class have recognized the necessity for standardization of their methods of analysis, but the equally important work of sampling has been left too long in the hands of the ignorant, and until this is remedied by the chemist himself taking control, we shall have disputes between buyers and sellers concerning the purity and strength of "analyzed" and other chemical products.

JOHN B. C. KERSHAW.

9 Grosvenor Road, Colwyn Bay,
Liverpool, England.

Price Fixing by the Idealist

To the Editor of Metallurgical & Chemical Engineering

SIR:—Among the most interesting features of the present commercial conditions growing out of the war is the question as to what constitutes a fair price, and how much profit shall be made on commodities required by the government. The problem is a perplexing one, and can never be solved to the entire satisfaction of all concerned, involving as it does so many phases of supply and demand, as well as the human frailties of greed and avarice—so that it is almost impossible to arrive at any cost figure upon which to base a fair margin of profit. This generation is witnessing a remarkable change in many things, and in the viewpoints from which things are looked at, and eventually the problem of gain will be solved just as drunkenness and autocracy are being solved by the people arriving at a decision as to what constitutes success or failure from a mundane point of view.

After all has been said and done—every man, woman, and child on earth values the good opinion of their fellows higher than anything else upon earth, and just as fast as we learn that ostentation and display are no longer sufficiently interesting to draw the homage we desire, just that fast will we solve the questions now so vexatious and trying to all of us. This war has taught us many things, and will teach us many more, and if the net result increases the happiness and contentment of man upon earth, the result will be worth all it costs. If our manufacturers and producers and middlemen can come out of this trying period chastened, and with a clean spirit, with the lesson of live and let live fully learned and digested, then we will see changes in our business morale, now regarded as chimerical.

The state must be greater than the individual, but the state can only maintain its greatness if its individual units are sound and true. So in this price-fixing we must have a frankness and honesty between

the state and the individual producer which has never been conceived of heretofore. Men are learning rapidly that beyond a certain line great wealth means more or less discontent, and that service to their fellowman is after all the most satisfying thing upon earth, whether required or not; and now the opportunity has come to us of the U. S. A. to show that our ideals go further than being merely the richest people upon the earth. Let our great captains of industry throw open their books to the government agents; let them say we pay so much to produce this article; we need so much to maintain our plants and properly take care of ourselves and our stockholders—beyond that point our profits are the property of the U. S. A., to be used to bring about that coalition of nations, which shall from now on make the whole world a better place to live in—not for the 10 per cent on top, but for the submerged 90 per cent, who for countless generations have borne the brunt and travail of life, but whom we now see have just as much right to human happiness and security as ourselves, and let our particular line of big business see that we do our part to give it to them.

H. B. COHO.

New York City.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.
Third National Exposition of Chemical Industries,
Grand Central Palace, New York, week of Sept. 24,
1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

CORRECTION

In the article by T. Kurahashi on "Recent Developments in the By-Product Coking Industry of Japan," Vol. XVI, June 15, 1917, page 700, the eighth paragraph should read:

"The Imperial Steel Works, the most distinguished steel and iron works in the Orient, have coke plants for the blast furnaces. They were formerly beehive ovens of the Coppee type, but are now by-product ovens of the Semet-Solvay and Koppers types."

Memoranda on Submarines

The Engineering Committee of the National Research Council issues the following data to guide those desirous of helping to circumvent the Enemy's submarine campaign by means of invention and suggestion. Any communication on the subject should be addressed to W. F. Durand, vice-chairman of the committee, at Washington.

Submarines operate singly or in groups as may seem best suited to local or special conditions.

They are supposed, where circumstances favor, to lie on the bottom at rest and with listening devices attempt to detect the approach of vessels. On receipt of evidence that a vessel is approaching, they rise to a level permitting observation with periscope, and then maneuver accordingly. When in water too deep to per-

mit lying on bottom, the submarine must maintain steerage way in order to hold its level of submergence. The minimum speed at which this can be done will range with circumstances from 2 to 4 knots. The maximum depth of submergence is about 200 ft. The usual depth of running is from 50 to 100 ft.

They have been supposed to return to the home base at intervals of 30 to 35 days. The total radius of action will presumably range from 5000 to 8000 miles at a moderate cruising speed of 10 or 11 knots. The high speed emerged will range from 14 to 18 knots, or possibly more in latest designs. The maximum submerged speed is about 10 knots.

Hidden bases have been presumably used off the Irish and other coasts. There have also been suspicions of bases on the coasts of Greenland and Iceland. Submerged bases for oil and supplies are used.

The time required from emergence to submergence will range from 1 to 3 or 4 minutes, according to circumstances. When submerged near the surface, the time required to raise the periscope, take a quick observation and lower it again, may range from 15 to 30 seconds. If desired, the submarine can follow an undulating path, rising and submerging alternately, at frequent intervals, at will. Or otherwise it may run fully submerged but near the surface and take frequent observation through the periscope. Modern submarines are provided with two or three periscopes. The loss or destruction of one, therefore, will not necessarily disable the boat.

Torpedoes fired from submarines are presumably aimed by changing the direction of the boat. This, however, is not assured in all cases. The torpedo, in order to run true, must travel at an immersion of about 10 ft. In smooth water it may be run at a shallower depth than in rough water.

Submarines may operate at night with less liability of detection, but with, of course, greater difficulty in picking up their target.

Submarines use the gyroscopic compass.

Sounds produced by the movement of a submarine through the water, including those traceable to the propeller, to movements of the rudder, etc., should permit of detection by the use of modern refined sound-detecting devices.

The distance at which a protecting net, plate, or shield or other means of exploding the torpedo before reaching the side of the ship must be located in order that such distance will render the effect of the torpedo harmless, will depend primarily upon (1) Weight of explosive charge, (2) Depth of torpedo when exploded, (3) Strength of the ship's structure. With modern torpedoes and a depth of 10 or 12 ft., and with the structure of modern merchant ships, distances of 20 or 30 ft. would perhaps be required in order to give good assurance against injury. With rough water and possibly much less submergence at the time of explosion, reduced distances of 15 or 20 ft. might prove sufficient. Experimental investigations on this subject show a very wide divergence among the results and no precise rule can be given. It may be added, however, that naval constructors generally are satisfied that the distance at which protecting plates or shields would have to be placed in order to secure immunity is so great as to render their use of very doubtful practicability.

Third National Exposition of Chemical Industries

Everything points to the Third National Exposition of Chemical Industries to be held at the Grand Central Palace, New York, during the week of Sept. 24th, being a much greater success than its predecessors. It will be the largest and most complete exposition of these industries ever held at any place in the world.

At the last exposition two floors of the big building were occupied by 187 exhibitors. This year three floors, possibly more, will be occupied. Already the list of exhibitors contains 250 names of companies entering every field of industry.

On Monday, Sept. 24, at 2 P. M., opening addresses will be made by Dr. Charles H. Herty, chairman of the Advisory Committee of the Exposition and editor of the Journal of Industrial and Engineering Chemistry, by Prof. Julius Stieglitz, president of the American Chemical Society, and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers.

Among other speakers on the program for other days are Mr. W. S. Kies, vice-president National City Bank, who will speak upon "The Development of Export Trade with South America"; Prof. Marston Taylor Bogert, chairman Chemistry Committee, National Research Council, who will speak upon "The Operation and Work of the National Research Council for the National Weal." Dr. L. H. Baekeland of the Naval Consulting Board will make an address on "The Future of American Chemical Industry."

One day will be devoted to a symposium upon the national Resources as Opportunities for Chemical Industries, and among the speakers will be: Mr. C. H. Crawford, assistant to president of Nashville, Chattanooga & St. Louis Ry.; Mr. V. V. Kelsey, chemist-industrial agent, Carolina, Clinchfield & Ohio Ry.; Dr. E. A. Schubert, mineralogist-geologist, Norfolk & Western Railway; Dr. T. P. Maynard, mineralogist-geologist, Central of Georgia Ry. and Atlantic Coast Line Ry.; Dr. J. H. Watkins, geologist, Southern Railway.

The motion-picture program will be one of wide interest. The American Cyanamid Company and General Electric Company have already arranged to supply their films. The Bureau of Commercial Economics at Washington will supply many toward completing the range of industrial films.

Fall Meeting of American Electrochemical Society

The thirty-second general meeting of the American Electrochemical Society will be held in Pittsburgh Oct. 3 to 6. A special feature of the meeting will be a series of papers and discussions on Electrochemical War Supplies, and the part the electrochemical industry will play in the present struggle.

The committee in charge is outlining an elaborate program of technical sessions, visits to industrial plants and entertainment features. It invites the delegates to arrive in Pittsburgh on Wednesday, Oct. 2, so as to get together informally and enjoy some recreations which have been planned for them.

On Thursday, Oct. 3, a regular meeting of the society will be held in the morning, with optional excursions to industrial plants in the afternoon. In the

evening an illustrated lecture on a semi-technical subject will be given.

On Friday, Oct. 4, a symposium on Electrochemical War Supplies will be held in the morning, followed by excursions to industrial plants in the afternoon. A subscription dinner will be held at the William Penn Hotel in the evening, with special entertainment features. The ladies are especially invited to be present at this function.

Saturday, Oct. 5, will be devoted to an all-day excursion, on a special train with complimentary luncheon, to several industrial plants in the Pittsburgh district.

An Opportunity for Metallurgists

Many technically trained men, beyond conscription age or otherwise, have wondered how they might now be doing their part to aid in winning our war. They have felt that a personal offer of service would only add another straw upon the shoulders of already overworked officials and bring no results, since the government could scarcely know the individual and material equipment of the man or concern making the offer. A plan is well under way at present, however, which will allow the individual engineer to use as much of his time and energy as is available in attacking problems directly connected with the war.

In the furtherance of this scheme, the national engineering societies will receive from various governmental departments a list of the unsolved engineering problems confronting them. Such of these problems as would probably fall within the scope of their individual membership will be listed and sent to each member, with the earnest request that the recipient devote as much of his time as possible to the solution of that problem nearest fitted to his knowledge, staff or plant. In this way will each engineer of this country, and there are dozens of thousands of them, be able to apply his own personal resources to the full extent of his time and inclination, knowing that his efforts will be directly contributing toward the successful prosecution of the war.

Through properly constituted committees he will also be kept constantly in touch with other engineers working on various phases of the same problem, and when success crowns their efforts, the results will be forwarded to the proper governmental department through the National Research Council.

At a meeting of the New York Section of the American Institute of Mining Engineers, held at the Machinery Club on July 20, a very clear call was sounded which should be heeded by metallurgists throughout the country. Mr. DONNELL F. HEWETT of the United States Geological Survey called attention to the fact that in order to produce 50,000,000 tons of steel, requiring 17 lb. of 80 per cent ferromanganese per ton, would call for the consumption of not less than 400,000 tons of this alloy, necessitating the mining, transportation and smelting of over a million tons of manganese ore; the exact amount depending, of course, upon the tenor.

Mr. Hewett further pointed out that the production of the United States could not possibly be expected to fulfill our minimum requirements, inasmuch as the whole body of developed ore is only equal to some three years' consumption. The mining of manganese has indeed been growing by leaps and bounds, even to the

extent of doubling its output annually, but unlimited expansion and intensive production are not likely owing to the nature of the known deposits—they are local enrichments in the upper few hundred feet of the earth's crust, quite local and variable in extent, geological environment, and mining methods. The best expectancy is for a small production of high-grade ore containing more than 40 per cent manganese suitable for making ferromanganese; a larger production of medium-grade ore containing 15 to 40 per cent manganese, and also a large production of low-grade ore, containing less than 15 per cent manganese, the latter two classes suitable for making spiegel. The present deficit between production and consumption is now being met by imports, largely from Brazil. The Brazilian deposits could easily tide us over the interim were we assured of adequate water transportation, which unfortunately is growing scarcer and dearer, and may even be absolutely terminated, the ships being diverted into more necessary military service.

Here is the metallurgist's opportunity. The winning of the war means the production of steel, more steel, millions of tons of steel, and each pound of steel requires a certain fraction of a pound of manganese as a deoxidizer. If, as is easily possible, this manganese may not be had at any price, the possession of unlimited iron ore, blast furnaces, steel mills and munition factories will avail us nothing, unless the metallurgist can point out some way of using our limited supply of this important element to better advantage, or develop some acceptable substitute, as was clearly pointed out in the general discussion following the formal addresses.

Good steel can be made in the crucible process without manganese. Other processes operate with heavily oxidizing conditions in the furnace laboratory, and the result is a steel containing much oxygen in solution, or as oxides, alloyed, or mechanically mixed. If poured in that condition the resulting ingot would be "red-short" and useless, cracking and breaking badly under rolling, forging or other mechanical work. The early English-made Bessemer steel had this defect, and only after much experimental work which drained his resources did the inventor discover that manganese remedied the defect. It appears, however, that the presence of manganese is not so important as the *absence* of oxygen and oxides. Manganese stands pre-eminent as an oxygen eliminator, not only reducing any iron oxide which it may encounter in the steel, but forming a liquid slag which washes out other mechanically entrapped oxides and separates freely from the hot metal. A certain excess not only insures good, tough steel, but also neutralizes largely the harmful effect of that omnipresent and tenacious element, sulphur.

In these two respects manganese is matchless. Silicon and aluminium metal are powerful deoxidizers, but must be added in somewhat larger quantity than manganese; further, the oxides which are formed are very infusible and tend to remain in the metal itself, forming "sonims," solid non-metallic impurities very detrimental to the tenacity, toughness and general usefulness of the resulting metal. However, it is possible to substitute silicon for perhaps 25 per cent of the manganese, the resulting manganese silicates being readily eliminated from the liquid metal.

An acceptable substitute must therefore have these properties: First, it should remove oxygen from iron

compounds or solutions; second, the resulting oxides should be easily and thoroughly eliminated from the steel; third, the presence of an excess should not be detrimental to the metal.

Owing to the exacting scrutiny and slow adoption which such a substitute would undergo, a more profitable line of attack would appear to be in the direction of a better utilization of our present supplies of manganese. Two possibilities are here open: first, to get more of the manganese from the available ores into usable condition, and second, to use that manganese metal more efficiently.

Manganese ores may be regarded as mixtures of oxidized iron and manganese compounds, with more or less gangue material, often siliceous. If the ore is high in iron and low in manganese it is usually smelted in an ordinary iron blast furnace, operating very hot. The result is an iron-manganese alloy called spiegel, containing perhaps 5 per cent of carbon and 20 per cent manganese. Concentration of manganese in the blast furnace appears to be impossible, if one considers the silica which is always present. If the furnace is run too hot as much as 20 per cent of the manganese may volatilize and be lost; on the other hand, in a cooler furnace the manganese replaces the iron in the silicate slag and is wasted.

Higher manganese alloys—"ferromanganese"—are prepared in the electric furnace, which makes a standard product containing 80 per cent manganese and low in carbon. The use of this alloy is seen to be indispensable in the production of low-carbon alloys; 17 lb. of manganese as spiegel would simultaneously add 20 points (0.20 per cent) of carbon to the metal. Spiegel is rather easily made, although very wasteful of manganese. Further than that, its use is limited to higher carbon steels. Still, the bulk of American ores are so low in grade as to produce nothing else, and at the same time may be rather high in silica and phosphorus. It would seem of prime importance to develop methods in which lower grade ores might be smelted to merchantable spiegel by concentrating the manganese before smelting, and by protecting it during smelting. The next step would be to develop methods of producing ferromanganese from spiegel, for which there are a number of interesting possibilities. Or, finally, the problem of producing manganese metal by direct electrolysis of ore in solution in a bath of molten metallic salts appears to await successful solution, and the various practical limitations and operating details determined. In this matter it appears highly important for the steel producer to cease demanding either 20 per cent or 80 per cent alloys and accept intermediate analyses.

A final, most interesting possibility would obviate the addition of certain quantities of manganese by the utilization of that manganese present in ordinary pig iron, or in the steel scrap melted in the open-hearth furnace.

It is well known that carbon, while having a rather low "affinity" for oxygen at ordinary temperatures, becomes more and more voracious in its appetite for oxygen, reducing even the most refractory oxides at higher and higher temperatures. Take the case of phosphorus and carbon—at room temperatures and even up to the temperature of the puddling furnace, phosphorus has a greater affinity for oxygen than carbon, and consequently is eliminated from the bath

before any considerable quantity of the carbon. The somewhat higher temperature of the open-hearth furnace represents a region where the relative affinity of the two elements is about equal, and the phosphorous and carbon are eliminated from the bath almost simultaneously. At the yet more intense temperature prevailing in the Bessemer converter, however, the affinity of carbon has become greater than of phosphorus, and the former must be completely eliminated before any loss in the phosphorous occurs—exactly the opposite state of affairs from that which occurs in the manufacture of wrought iron.

The same thing is true of manganese. In all normal furnace operations the elimination of manganese is complete before the last of the carbon—in other words, at those temperatures manganese has a greater affinity for oxygen than carbon. But from the first, Bessemer steel has been made from pig containing so much manganese, and at so high a temperature that at the end of the carbon blow there is still enough "residual manganese" to effectually kill the melt. A modern metallurgist does not wonder that when Sir Henry Bessemer's process was first applied to English pig, low in manganese, the result was impossible. Again, the first manufacturers of basic steel were rather puzzled to find that toward the end of the heat, after all manganese had once been eliminated from the bath, test bars suddenly showed *unmistakable presence of considerable manganese*.

The explanation seems simple. The temperature has risen to such a point that the affinity for oxygen of the remaining carbon in the melt reaches and passes that of manganese, with the result that manganese is reduced from the slag and re-enters the metal.

Why is it not possible to effectually "kill" a metallic bath (if elimination of the oxygen is the prime desideratum) by a proper determination and application of the physico-chemical laws governing the relative affinity of manganese, carbon and other elements for oxygen in such a manner that a large part of this most important work may be done at a proper temperature under a slag no higher in manganese than the low-grade ores of this country and utilizing the same manganese previously eliminated from the bath with the other "impurities"?

September Meeting of American Chemical Society

War Problems to Be Discussed at Boston

The September meeting of the American Chemical Society will be held in the buildings of the Massachusetts Institute of Technology, Charles River Road, Cambridge, Mass., Sept. 11, 12 and 13, 1917. The Northeastern Section has been requested by the directors to omit the usual annual banquet and excursions, and to arrange a program characterized by simplicity and seriousness, and bearing as fully as possible on questions concerning the activities of chemists—both in the government service and in the industries during the war.

The following is a list of the chairmen of local committees:

Executive—H. P. Talbot, Massachusetts Institute of Technology, Cambridge, Mass.

Finance—A. D. Little, 93 Broad Street, Boston, Mass.

Registration—K. L. Mark, Simmons College, Brookline, Mass.

Entertainment—R. S. Williams, Mass. Inst. of Tech., Cambridge, Mass.

Press and Publicity—R. W. Neff, 22 India Square, Boston, Mass.

Entertainment of Ladies—Mrs. A. D. Little.

Registration will be conducted at the buildings of the Massachusetts Institute of Technology, Cambridge, except on Monday, Sept. 10, when it will be held at the Hotel Lenox.

Society headquarters will be at the Hotel Lenox at the corner of Boylston and Exeter Streets.

The use of the Engineers' Club, at the corner of Arlington Street and Commonwealth Avenue, will be extended to all members of the Society.

GENERAL PROGRAM

Monday, September 10

4.00 p. m.—Council Meeting. Engineers' Club.

7.00 p. m.—Dinner to the Council at the Engineers' Club (tendered by the Northeastern Section).

Tuesday, September 11

10.00 a. m.—General Meeting of the Society in the Massachusetts Institute of Technology.

Address of Welcome:

Dr. R. C. MACLAURIN, President Massachusetts Institute of Technology.

Response:

JULIUS STIEGLITZ, President Americal Chemical Society.

General Papers.

2.00 p. m.—General Conference on Chemistry and Chemistry in Warfare, opened by WILLIAM H. NICHOLS, Chairman Committee on Chemicals, Council of National Defense. MARSTON T. BOGERT, Chairman Chemistry Committee, National Research Council.

5.00 p. m.—Harbor trip to Hotel Pemberton, where an informal shore dinner and smoker will be held.

Wednesday, September 12

Morning.—Conferences of Divisions.

Afternoon.—Divisional Meetings.

Evening.—President's Address, Huntington Hall, Rogers Building, Massachusetts Institute of Technology, Boylston Street.

Thursday, September 13

Morning and Afternoon.—Divisional Meetings.

The Metallurgy of Lead Ores in the Lower Mississippi Valley¹

By Herman Garlich, E. M.

The first metallurgists in Missouri were the Indian and the hunter. The early settler learned to procure his bullets either by melting ore in his camp fire or by throwing pieces of galena on an old stump and depending on the usual roasting and reaction method to obtain the metal.

Various other older practices may be passed over lightly, as many of them are now practically abandoned. The earliest smelting furnace was the log hearth, which was followed by the "ash" furnace, the English reverberatory, the Backwoods and water-backed hearth.

¹An abstract of a paper to be presented at the St. Louis Meeting of the American Institute of Mining Engineers, October, 1917.

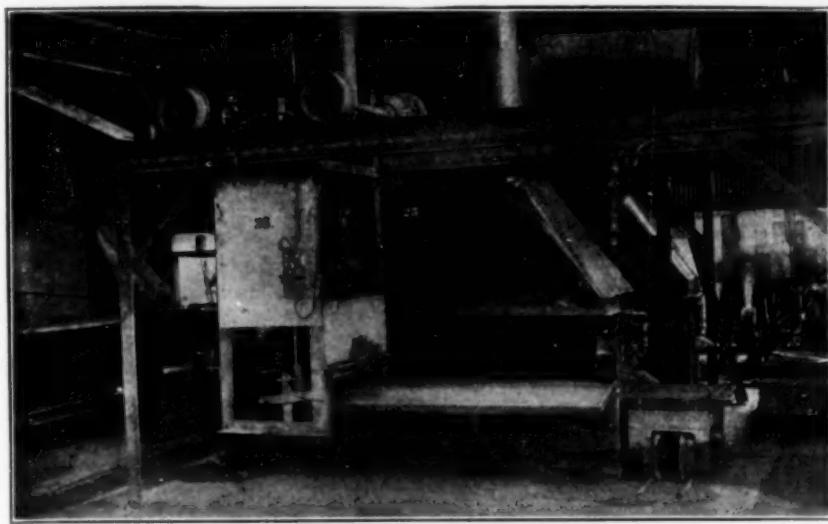


FIG. 1—RABBING MACHINE AT BEGINNING OF TRIP

Much information regarding these processes may be obtained from *Missouri Geological Survey*, Volume VI; *Illinois Geological Survey, Bulletin 21*; and Pulsifer: *Notes for a History of Lead*.

The reverberatory and hearth methods require pure ores. On this class of ores these processes give fair

ANALYSES OF ORES AS MINED IN SOUTHEAST MISSOURI, AND OF VARIOUS GRADES OF RESULTING CONCENTRATES

Ore	Al ₂ O ₃ , %	Cu, %	Pb, %	SO ₃ , %	Fe, %	Al ₂ O ₃ , %	CaO, %	MgO, %	Zn, %	Si, %	Ni and Co, %
Ore	0.12	0.06	5.7	5.0	4.1	4.9	25.5	14.2	0.8	2.0	...
High-grade concentrates	0.7	0.13	73.2	1.0	3.5	..	2.6	0.8	0.4	15.0	0.05
Medium concentrates	1.3	0.12	68.6	1.4	4.6	..	3.1	1.4	0.8	15.5	0.06
Low-grade concentrates	1.0	0.30	65.8	0.5	3.1	0.5	4.3	2.8	1.7	13.7	...
FLOTATION SLIMES	0.50	45.0	9.6	4.4	3.1	7.5	4.2	4.0	12.3
High-grade Joplin concentrates	3.7	0.05	57.8	6.0	2.7	..	2.2	1.4	9.4	15.5	...
Joplin concentrates	...	80.2	1.1	1.0	..	0.4	..	1.7	13.3

results when care is taken in smelting. The yield ranges from 80 to 90 per cent of the lead in the ores, allowing no recovery in fume. The blast furnace preceded by roasting in reverberatory is adapted to ores that are less rich in lead, and contain impurities which would cause severe losses if treated by any other process. Also, when there is a large amount of ore to be treated, with scarcity of labor, the blast-furnace process is the more economical.

Analyses of the ores as mined in southeast Missouri—which are about the average of the district—also analyses of various grades of resulting concentrates, show that the metallurgy is simple, the removal of the sulphur and the slagging of the dolomite in the blast furnace being of prime importance.

The big improvements which have revolutionized the metallurgy of the Mississippi Valley ores in the last 10 or 12 years are:

1. The introduction of Hunting-

ton-Heberlein pot roasting, preceded by a preliminary roast in a mechanical furnace (Godfrey), subsequently smelting in the blast furnace and filtering all fumes through cotton or woolen bags.

2. The introduction of the Dwight-Lloyd sintering process, which eliminated preliminary roasting of the concentrates (but not of the mattes), with subsequent smelting in blast furnace with bag-houses attached.

At Herculaneum, the Godfrey pre-roasting furnaces were abandoned in the Huntington-Heberlein process, and the Wedge roaster was adopted for the pre-roasting of mattes. Later it became apparent that the elimination of sulphur was still unsatisfactory, and that there was an undesirable but necessary dilution of the concentrates from 70 to 65 per cent lead to 40 and 45 per cent to render the Dwight-Lloyd machine applicable with a single roast.

To avoid these objections, the double roast is being installed by both the Herculaneum plant of the St. Joseph Lead Co. in Missouri, and the Federal plant of the Federal Lead Co. in Illinois. A rapid preliminary roast is given on a separate line of Dwight-Lloyd machines, and this pre-roasted material is then turned over to another set of Dwight-Lloyd machines (Herculaneum), or to Huntington-Heberlein pots (Federal) to reduce the sulphur of the finished product to about 2 to 2½ per cent, and with its lead contents increased to 50 or 55 per cent.

It is expected that the double roast will effect the following improvements over present methods:

1. To avoid the large production of mattes which lock up lead and require expensive re-treatment for its recovery.
2. To avoid diluting a 65 to 70 per cent lead concentrate to 40 to 45 per cent, which means large additions of barren fluxes.
3. To utilize to the fullest extent the fluxing values in the ores. This means that no limestone should be added

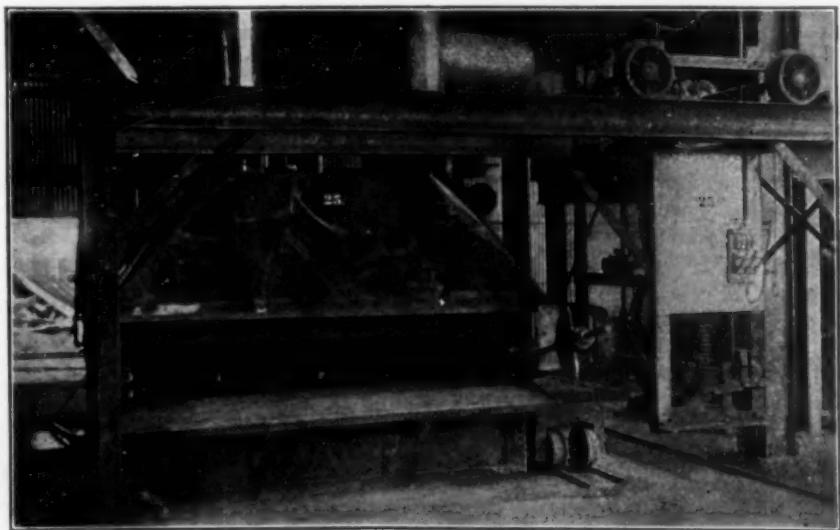


FIG. 2—RABBING MACHINE AT END OF TRIP

to a blast-furnace charge, while some silica and iron will be required. The resulting blast-furnace slags will contain from 6 to 7 per cent MgO, with a corresponding increase in blast-furnace capacity for original concentrates.

4. To recover a part of the copper in the concentrates, which metal is at present mostly oxidized and lost in the large amount of slags made.

The other important improvement in the metallurgy of Mississippi Valley lead ores was the mechanically rabbed hearth, known as the "St. Louis hearth." This machine was developed at the Collinsville plant of the St. Louis Smelting & Refining Co., and has been fully described by W. E. Newnam.²

The St. Louis hearth, which is illustrated in Figs. 1 and 2, is applicable only to concentrates assaying 68 per cent or more in lead, and therein differs from the Huntington-Heberlein and Dwight-Lloyd methods, which treat concentrates of varying grades.

When concentrates assay over 70 per cent it is considered that the hearth shows better recovery in lead, and is the most economical method, although the double roast, when perfected, promises to be equally as cheap as to cost, with the advantage of being able to treat all grades of concentrates.

The peculiar advantages of the mechanical hearth for the higher grade concentrates are:

1. It treats the concentrates undiluted with any flux.
2. It is a very efficient desulphurizer, expelling 95 per cent of the sulphur.
3. It retreats all the dust and fume produced, leaving the gray slag as the only product to be sent to the blast furnace, with a large reduction in slag and matte produced.
4. The hearth makes a total extraction of 82 to 84 per cent of the lead contained in 70 per cent concentrates. With concentrates assaying 75 to 80 per cent in lead, 90 to 95 per cent represents the total extraction, leaving from 5 to 10 per cent of lead contents in the gray slag. This practically eliminates any retreatment of mattes.

The mechanical rabbling machine is limited to 68 per cent lead concentrates, and for this reason, where lower grades of concentrates are received at Collinsville, the Dwight-Lloyd machine must be used as an auxiliary. All mattes produced by smelting the gray slag of the hearths and the Dwight-Lloyd sinter at Collinsville can be easily handled *raw* on the Dwight-Lloyd, so that a Wedge roaster is not needed for pre-roasting.

The St. Joseph Lead Co. is erecting at Herculaneum 12 St. Louis hearths to be used in connection with the double-roast process for the treatment of any excess of high-grade concentrates.

In the southeast district, about 75 per cent of the output of the mills is a high-grade product, applicable to hearth work, the remainder being lower-grade concentrates and flotation slimes. In order to sweeten the mixture for the double roast (*i.e.* to raise its grade) it is necessary to use a certain proportion of the high-grade concentrates for this purpose. The balance of the concentrates should be worked by the mechanical hearth to obtain the most economical results both as to cost and recovery.

²See Transactions, American Institute of Mining Engineers, 1916, Vol. 54, p. 485, or Metallurgical and Chemical Engineering, Vol. XIII, Dec. 15, 1915, page 974.

The lead produced from Missouri ores contains very few impurities, and when subjected to a single liquation process can be used for all purposes except corrodung. A typical analysis of Missouri undesilverized lead is as follows:

Ag, 0.0080 (2.4 oz. per ton); As, trace; Sb, 0.0030; Bi, trace; Cu, 0.0800; Fe, 0.0015; Zn, trace; Ni and Co, 0.0080; lead by difference, 99.8995.

The Herculaneum and Collinsville plants desilverize part of their lead, recovering about 1 to 2 oz. of silver per ton, and producing an unusually pure lead for the manufacture of white lead and other purposes requiring a very pure lead.

The following analysis of southeast Missouri "refined" indicates the unusual character of Missouri desilverized lead:

Ag, 0.005; As, trace; Sb, 0.0020; Bi, trace; Cu, 0.0002; Fe, 0.0004; Zinc, 0.0004; Lead by difference, 99.9965.

The difference between southeastern Missouri and western refined lead is almost entirely due to bismuth (about 0.05 in Western refined) from which the Missouri ores are singularly free.

The refining of the Missouri crude lead for corrodung purposes follows the usual practice, except that no softening furnaces are necessary.

At Collinsville the lead from the blast furnace is poured molten into the drossing kettle. After carefully drossing to eliminate as much copper as possible, it is pumped into a desilverizing kettle. The hearth lead is charged as pig directly into the desilverizing kettle, drossed, and desilverized. Zinc is added, stirred in, and the zinc-silver-lead alloy (crust) is removed. This first crust is reworked in succeeding kettle charges until sufficiently high in silver to be set aside. The resulting retort bullion (lead riches) assays from 500 to 600 oz. Ag per ton, and represents a concentration of the silver contents of 250 to 300 tons of lead into 1 ton of retort bullion. The zinc consumption per ton of refined lead produced is about the same in amount as is consumed in refining argentiferous bullion. Special attention must be given to removing as much copper as possible from the lead to be desilverized.

The quantity of zinc-silver-lead alloy made is insufficient in quantity to warrant the operations of retort and cupels, and heretofore the alloy has been sent to some outside refinery to be separately distilled in retorts, and returns are based on the sampling of the various products obtained, such as retort bullion, dross, spelter, and blue powder. The assay results check quite closely. Retorts and cupels are being installed at Collinsville so as to be able to treat the alloy whenever occasion demands.

St. Louis, Mo.

The Composition of Shell Steel

By Reginald Trautschold, M.E.

The steel used for the manufacture of shells must possess certain physical properties, and with the object in view of assuring such properties the various governments have adopted specifications covering the allowable chemical composition of the stock used. Certain variations must, perforce, be permissible—the chemical "tolerance." The steels universally used may be classified as carbon steels, to which certain other chemical elements are added for improving the quality of the steel and in which there must necessarily be a trace

of other elements which may not be exactly desirable, but cannot be avoided in commercial production.

The object of the chemical specifications is to secure a metal possessing the requisite physical properties, for the strains to which a shell is subjected are all physical, and the efficiency of the shell—its destructive capabilities—is governed not by chemical but by physical properties. Particularly are the physical properties of the steels important in high-explosive shells which are shattered by the charge confined within the projectile. In the case of shrapnel, the properties of the steel are not so important, the main requisite for them being a sufficient tenacity for the projectile to remain intact until moment of "breaking," i. e., the moment of ejection of the shrapnel balls.

The English specifications for high-explosive shell steels are probably the most exacting of any, but those imposed by the United States are sufficiently exacting to prohibit the use of much otherwise available and excellent steel stock. Apart from the iron content, the percentages of chemical elements which may occur in high-explosive shell steel are given in Table 1. With the exception of manganese, only the maximum allowable percentages are given, so there would seem to be quite a permissible variation in composition. Nevertheless, the allowable percentage of certain elements is

so small that exacting mixtures of metal are essential, whether the open-hearth or the converter process is employed in the production of the steel. The specifications of other governments differ somewhat, but the variations cited may be taken as typical of what is generally considered good and necessary practice.

Compared with such requirements, then, the chemical properties of the steel used by the Germans are

United States Specifications					
	Minimum Per Cent	Maximum Per Cent		Minimum Per Cent	Maximum Per Cent
Carbon		0.55	Phosphorus		0.04
Manganese	0.40	1.00	Copper		0.10
Silicon		0.30	Nickel		0.50
Sulphur		0.04			

of particular interest. For, as it must be admitted that the "art" of war has been developed to a high point by this nation, it is altogether probable that the manufacture of shells has been given most careful attention and developed to a high degree of perfection.

During the first year of this great war, a number of fragments of the German high-explosive shells which caused such damage in Belgium and France were collected and carefully analyzed in England. These shell pieces were not selected samples, but fragments picked up on battlefields and were presumably parts of projec-

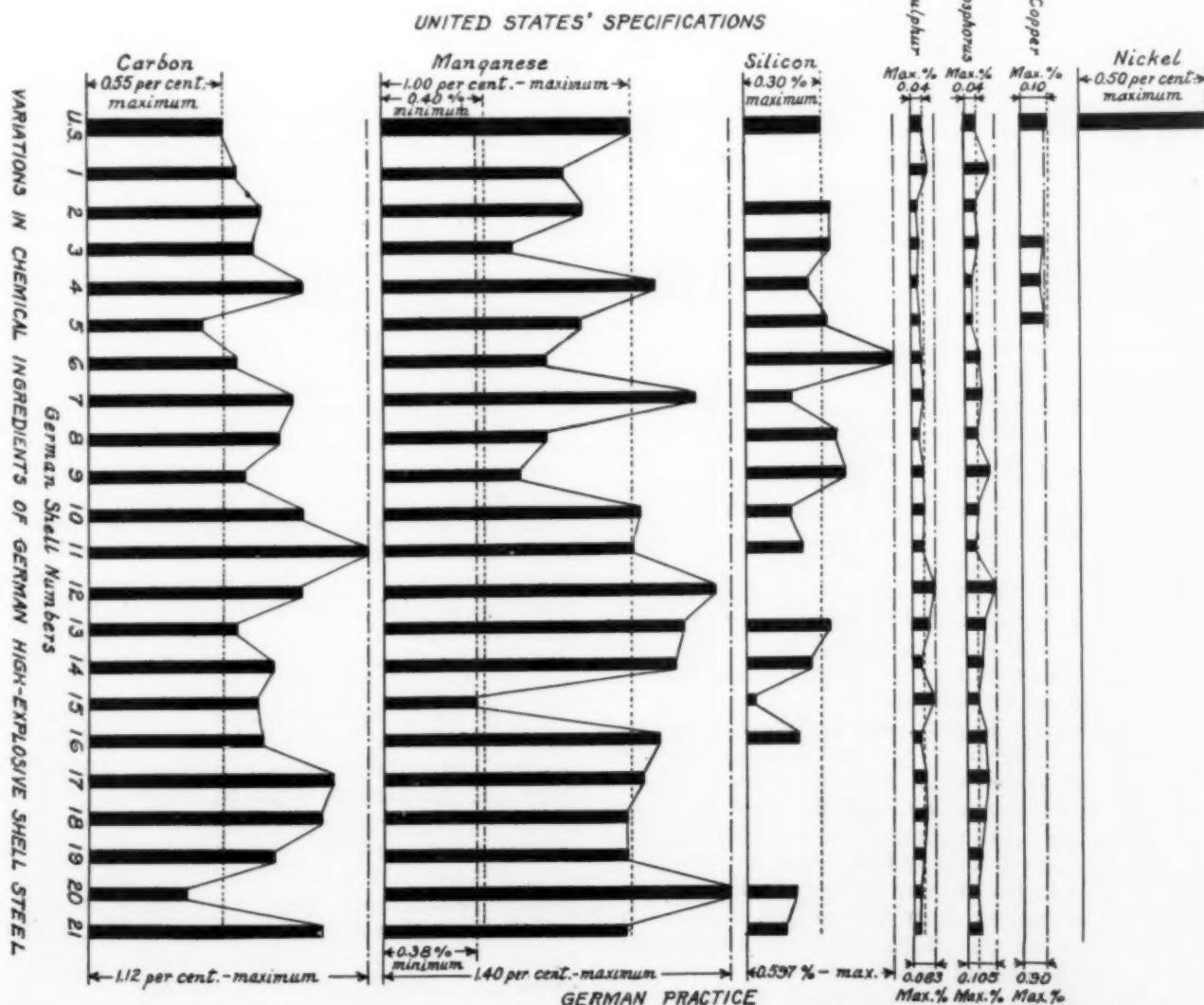


FIG. 1—GRAPHICAL COMPARISON OF UNITED STATES AND GERMAN HIGH-EXPLOSIVE SHELL STEELS

tiles made before the outbreak of the war—projectiles upon the deadly success of which hope of the subjection of Europe, if not of the world, had been based. That is, the fragments collected were unquestionably pieces of the most perfect and most destructive shells the Germans had been able to manufacture at a time when they were in position to obtain any quality of steel they might deem desirable for shell production. This is an important point, for fragments of shells picked up more recently might be of composition which the Teutons had been compelled to adopt by reason of inability to secure metal of better grade. The analysis of the collected samples, which was published by Dr. J. E. Stead in "The Engineer," probably, therefore, depicts the best German practice.

The proportion of the various elements, exclusive of the iron, found in twenty-one of these high-explosive shell-fragments is plotted in Fig. 1. Comparing the chemical composition of these German shells with corresponding allowable percentages in the United States specifications, it will be noted that *not one* German shell would have passed our requirements. Yet every one of these shells was a highly efficient destructive missile.

In the case of carbon content, which, according to our specifications, is limited to 0.55 per cent, there were only two of these tested shells which did not exceed this maximum: in one case the excess was over 100 per cent, while the average excess was 28 per cent.

The manganese content, upon which both a maximum and minimum allowable percentage is fixed in our specifications, does not vary so greatly between German and American practice. Only one of the German shells showed less manganese than our minimum allowance of 0.40 per cent, and this difference was so very slight as to indicate that opinion is pretty well agreed as to the minimum amount of manganese which high-explosive shell steel should contain. About half the German shells equaled or exceeded our allowable maximum of 1 per cent manganese, indicating that our enemies consider the addition of manganese a greater advantage than do our steel experts.

In the case of silicon, when this element is present in German shells, the amount does not differ greatly from our practice, although in one case the German shell contained nearly 100 per cent more than allowable United States maximum. In one quarter of the analyzed shell fragments, however, little or no silicon was found, so it is evidence that this element is not considered so essential in the manufacture of high-explosive shell steel that it need be added to the basic Bessemer steel which doubtless furnished the stock, while, at the same time, an excess of such element seems not to be considered detrimental.

The presence of sulphur and phosphorus is the cause of eliminating much of our steel for high-explosive shell production, but such seems not to be the case in Teutonic manufacture. Although the Germans seem to strive for low percentages of these ingredients they do not reject steel running even some 100 per cent to 150 per cent higher in these ingredients than would be permitted in steel for American explosive shells.

In the few German shells which showed any trace of copper, the content would have been allowable in American practice, but quite evidently the presence of this element is not considered of any particular advan-

tage, for by far the larger majority of the shell fragments showed no trace of it.

In the case of nickel, which may be present according to American specifications in the proportion not exceeding 0.50 per cent, no trace was found in any of the analyzed shells. This would seem to show that the addition of nickel is not considered indispensable by them.

Table 2 gives the allowable chemical variations which would be permitted by the Germans, basing the percentages upon the twenty-one typical shells which were carefully analyzed. The establishment of definite specifications on twenty-one analyses could not, of course, be taken as conclusive evidence that the variations shown may not be exceeded, but, as there is no reason to assume that the fragments examined were other

TABLE 2
Probable German Specifications

	Minimum Per Cent	Average Per Cent	Maximum Per Cent
Carbon	0.40	0.75	1.12
Manganese	0.40	0.93	1.40
Silicon	0.00	0.28	0.60
Sulphur	0.00	0.05	0.085
Phosphorus	0.00	0.06	0.105
Copper	0.00	...	1.00

than typical, such specifications may be safely taken as acceptable to the war lords. These allowances may be more exacting than those permitted by the German government, but they are certainly not more liberal.

Should some such specifications as these be adopted by our Government, it would make available a considerable tonnage of steel which to-day cannot be used in the production of high-explosive shells. With a larger steel supply available, the production of shells could be greatly accelerated. There is no question that shells could be produced in this country quite equal to those made in Germany—a quality of shell which heretofore has proved quite efficient.

The wide variations in the composition of German high-explosive shell steel indicate that not only are no exact chemical requirements imposed, but also indicate the strong probability that the requirements for acceptable shell steel are not based on chemical but upon physical properties. This theory is indorsed to some extent by the French who lay particular stress on exhaustive and reliable physical tests while imposing little limitation as to chemical composition.

The chemical composition of steel can only be taken as indicating what its physical properties *may* be. It cannot be accepted as a definite indication, and for this reason all governments require confirmatory physical tests. It would seem the part of wisdom, therefore, to rely more on physical tests and impose less strenuous chemical requirements.

A shell possessing the requisite physical properties must be satisfactory from the point of view of destructiveness, irrespective of its chemical composition. Some such reliable test as the hydraulic test required by the French government for its high-explosive shells would appear to be the prime necessity. This test may be easily made and would automatically establish sane chemical requirements. Similar practice on the part of our Government would accelerate production, cheapen cost of manufacture and make available much steel which is at present barred by specification.

Chemical Engineering Aspect of Renovating a Sulphide Mill*

By Hugh K. Moore

In the winter of 1909 and 1910 I was called to La Tuque, P. Q., Canada, in order to render what services I was able in renovating and reconstructing a pulp mill running on the so-called sulphate process. The word sulphate is a misnomer and I have always objected to the term, which even though accepted in the trade as descriptive of the process, really is not descriptive of the process by which the pulp is made. As you all know, the so-called sulphate process is so named from the large use of sulphate of soda as a raw material. This sulphate of soda, however, is not used directly in cooking, as it is reduced beforehand to sodium sulphide, sodium hydrosulphide, caustic soda and carbonate of soda. The essential difference between this process and the soda process is the sulphide content of the cooking liquor. The name sulphide then is descriptive of this particular process of making pulp and is as correct as "soda" and "sulphite," names which clearly designate the other well-known processes by which pulp is made.

Now I wish to say, lest you expect too much, that when I went to La Tuque I did not know what a sulphate mill was and understood nothing about the process; and, furthermore, I was called upon so suddenly that I had not time to inform myself as to the nature of the process before I started.

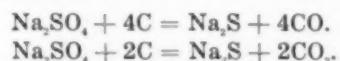
Before going into details as regards the processes and innovations a few remarks on the scope and limitations of this article may not be out of place. In the first place, this being about one particular mill instead of several mills, I purposely suppress all data on costs, maintenance, repairs, etc., neither shall I give any data as to yield per cord of wood, or salt cake, fuel, labor, repairs, etc., etc., per ton of pulp. Neither shall I give any figures on any of the installation costs. In stating the facts and methods of overcoming the difficulties I want it to be particularly understood that I am not claiming credit for all the different changes made. Many of these I made, but many were made by Mr. Brown, Mr. Lovett and others, many were combinations of ideas of all, and it would puzzle a Philadelphia lawyer to assign to whom credit for certain of these changes should be given. The idea in mind is not to assign credit to any one person or group of persons, but to show how a knotty problem was tackled and solved.

RÉSUMÉ OF SO-CALLED SULPHATE PROCESS

In order that those who have no more knowledge of the workings of the sulphide process than I had at the start (if there be any such) may have an understanding of the difficulties encountered, I think I had better give a short résumé of what the sulphide process is.

Woods of the conifer type are mechanically partitioned to form chips about $\frac{3}{4}$ in. square and $\frac{1}{8}$ in. thick through a chipper, and these are run into a digester. After the digester has the required amount of chips the cooking liquid or alkali is run in, the digester is closed and heated by live steam, keeping the pressure on top of the digester during the cooking at 90-100 lb., relieving the excess of liquor and steam which are separated

in a separator and blowing the steam into water to heat it so that it can be used in washing the pulp. When the digester is cooked it is connected with tanks and blown. The steam is blown off through vomit stacks, the liquor drained through false bottoms and the pulp washed according to the principles of systematic counter-current extraction. Now, owing to the propensities of this liquor for foaming the ordinary evaporator was not thought available so the liquor was passed through a disk evaporator, the source of heat being the waste gases from the steam boilers. The disk evaporator in brief is made of hundreds of pieces of iron plates set around a revolving shaft. As these disks revolve they dip into the liquor, then emerge from the liquor with a film of liquor thereon. The hot waste gases from boilers pass over these films evaporating the water. By having several of these in series and enough waste heat you can progressively concentrate the liquor. After passing through the disk evaporators heated by furnace gases the partially concentrated liquor passes another set of disk evaporators heated by gases from the incinerator. By this means it is possible to concentrate the liquor to 20 deg. Bé., where mechanical troubles place a limit to this method of concentration. From the disk evaporator it runs to an incinerator which is simply a brick-lined rotary furnace. The remainder of the liquor is evaporated and the residue charred so that it comes out as black ash which runs from the end of the incinerator on to the floor. The source of heat is the white-hot gases from the smelting furnace. This black ash is then shoveled over, sulphate of soda added thereto and thoroughly mixed therewith. Wood is now thrown into the smelting furnace and this black ash shoveled on top of the wood. Air from a positive blower is injected about 15-20 in. from the bottom of the furnace and the black ash burned, reducing part of the sulphate of soda to sulphide of soda according to the following equations:



Also part is reduced to carbonate of soda with small amounts of caustic soda and sulphate of soda passing through unchanged. The soda content in the black liquor is mostly reduced to carbonate of soda though part is also reduced to sulphide of soda. The molten alkali liquor runs from a spout into a dissolving tank in which is an agitator, while the hot gases pass through the incinerator charring the carbonaceous residue, making black ash in the front part of the incinerator and evaporating water in the further end of the incinerator, thence going through the disk evaporators and out of flue as above described.

This liquor in the dissolving tank is pumped to the alkali room, where it is tested and the requisite amount of lime is added whereby the sodium carbonate is converted to caustic soda. This is decanted by allowing the calcium carbonate to settle and withdrawing the supernatant liquor by means of a siphon. The first two washings are added together while the weak liquor of the last washings are pumped to the dissolving tank, and this constitutes the liquor in the dissolving tank into which the molten alkali runs as above stated. The strong washings constitute the cooking liquor for the digester, though some strong black liquor may be added as a diluent.

*A paper read at the Ninth Semi-annual Meeting of the American Institute of Chemical Engineers, Buffalo, N. Y., June 21, 1917.

This, in brief, is a description of the chemical end of the sulphide process.

DRAWBACKS OF PROCESS

Now let us consider what is wrong about the above process from the standpoint of a chemical engineer.

The process being a cyclic one, it obviously makes no difference at which point we start so long as we complete the cycle. Accordingly, I shall start with the evaporation of the liquid.

(1) From the above it will be seen that the process described is one of direct evaporation, the only good reason for the same being the difficulty of accomplishing it by multiple-effect evaporation. It will be noticed that there is a consumption of wood in addition to the heat evolved from the solids of the liquor itself. This consumption of wood I wish to state is in order to get over *mechanical* difficulties rather than an absolute necessity. The consumption of wood is small in amount and is well paid for in the increased production and saving of labor. Even if the sources of heat for evaporation were entirely waste heat, *i.e.*, heat which cannot be recovered and used in other parts of the mill, there is still a sound basis for putting in a multiple effect system, and those who argue to the contrary have an incomplete understanding of the problem involved. Suffice to say for the present that for every pound of solid matter in this liquor there are 5000 B.t.u., which is sufficient not only to do its evaporation but furnish heat to *eliminate the wood bill* and materially reduce the amount of coal consumed in the boilers.

(2) The disk evaporators get out of order and are a constant source of expense. The liquor has a tendency to polymerize and this clogs the disk evaporators. This polymerization is due to the hot flames through which it passes, not its concentration.

(3) The variations in the original strength of the black liquor are passed right on to the incinerators, which are unable to take care of these variations.

(4) The incinerators have a habit of "ringing up" in the inside, one side of the ring having molten alkali, the other side of the ring having black liquor. Now when this ring breaks the liquor runs on top of the molten alkali and an explosion follows. If this ring is located near the end the chances are that one or more men go to the hospital for burns, and the fear of things like this happening tends to prevent the keeping of men long enough in this department for them to become expert.

(5) The unevenness of the fire in the smelting furnace can only have one result, *viz.*, the rapid deterioration of the furnace, not only from expansion and contraction, but also from the stuffing action of the sodium sulphide sublimed with sodium carbonate followed by the oxidizing action of the air under these intermittent conditions of running.

(6) The fine particles of salt cake and alkali are carried from the furnace through the incinerator and disk evaporators and lost with the exit gases.

(7) The separation of the carbonate of lime in the causticizing room takes a very large equipment and is troublesome in the extreme if the liquor happens to contain even a small per cent of iron sulphide. It usually takes six hours to settle a tank once and the heat lost is considerable of an item. The chances of losing alkali in the sludge are considerable, either through accident or neglect of duty.

(8) The sludge, which has a value in itself, is lost and may be treated for lime if so desired.

(9) There is also the possibility of the lime getting into the pulp through careless siphoning here.

(10) The steam, which is separated from the relief of the digesters being blown directly into the water which washes the pulp, blows many impurities therein, which gives the pulp, and consequently the paper made therefrom, an odor which prevents it being used for some purposes; for example, flour bags.

(11) This relief contains somewhat over 200 gal. of turpentine a day which is equal in quality to the best gum turpentine. By the above method all this turpentine is lost.

(12) Now taking up the process of blowing the digester we find that a considerable amount of pulp is blown through the vomit stack and lost.

(13) Every digester blown discharges 18,000 lb. of steam into the atmosphere, the heat of which might be advantageously recovered and used in the mill.

(14) When we come to the washing of the pulp we find the process slow and cumbersome. A process full of inherent difficulties of clogging, which either means a check in production or a waste of alkali. Both of these usually occur.

(15) An appreciable amount of pulp is carried away in the digester liquor.

METHODS OF OVERCOMING DRAWBACKS

Having pointed out the objectionable features of the process as ordinarily carried out, let us consider the methods by which they were overcome and the experiments relating thereto.

EVAPORATION

As before stated, this black liquor is very cantankerous, foaming under the least provocation. Bearing this in mind we built a multiple effect evaporator specially designed to overcome this fault. At first we could not run it at anywhere near its theoretical capacity on account of the foaming propensities of the liquor. Among the experiments we tried was to run the foam and steam through a specially designed centrifugal steam separator run at a very high velocity by a direct-connected steam turbine, the object being to throw the separated liquor through periphery, letting the steam pass through the center to the next effect. This worked very well when the bubbles of foam were large, but when they were small and consequently compact and heavy there was not enough power in the turbine to carry on this increased amount of work. Neither was it advisable to make larger turbines because the power required was so great that the steam consumption would be so great that most of it would have to be wasted as only a small portion could be used in the evaporators.

We finally carried the liquor only about 1½ to 2 in. in the tubes in the first effect, 6 in. in the second effect, and increasing heights as the concentration proceeded. The principle of this objection was that foam was constituted of a globule of steam surrounded by a heavy film of liquor, and that if we could produce the foam and evaporate off the water in the film to make it break we should accomplish our purpose. Now the height at which the liquor stands in the tube limits the quantity of the resulting foam, other conditions, such as steam pressure density, etc., etc., being equal. Now this foam shooting up through the remainder of the hot tubes has

its films transformed into steam, so that there is so much steam and so little film that they readily separate the steam passing to the next effect and the liquor is returned to where it finds its way to the next effect. Care, however, must be taken that too much of the foam shall not be evaporated as gumming up of the tubes results. The levels were for a time maintained by specially designed floats and this was continued until the men got so expert that they were no longer necessary. Large separators were put between each effect to catch any occasional foam and return it to its proper effect. A solenoid was installed which could be regulated so as to return any liquor having over a predetermined strength, and this could be regulated with the greatest nicety. Owing to the mercaptans given off in the liquor which have a very corrosive action we found that we had to redesign many parts of the vacuum pump and substitute rubber rings for the cast-iron piston rings. We got rid of the calcium sulphate which precipitated on tubes by surrounding the tubes with water and putting an acetylene flame down through the tubes, thereby heating the calcium sulphate and cracking it off without overheating the tubes. What with redesigning condensers and other apparatus we finally evolved an evaporator of six effects capable of evaporating considerably over 4,000,000 lb. of liquor a day to a consistency of from 33 deg.-35 deg. Bé., and we have now obtained a uniform liquor. These multiple-effect evaporators made the disk evaporators obsolete and they were scrapped and all the resulting repairs, labor and shutdowns eliminated.

ELIMINATION OF INCINERATOR AND EXPERIMENTS RELATING THERETO

Now, having obtained a uniform concentrated liquor, we are in a position to start work on the elimination of the incinerator. In order to do this several preliminary experiments became necessary which at first sight may seem to have no connection therewith. Previous experiments had shown that iron would not stand either the alkali liquor or the alkali gases under the usual conditions. Experiments were now conducted to see if it would withstand these if kept at temperatures not exceeding 400 deg. Fahr. The preliminary experiments seemed to show that it would, so we then obtained a steam boiler, erected it and built a smelting furnace in front of it, passing gases under the boiler and through the tubes just as if we were burning coal. Before starting we had an inspector from the Hartford Insurance Company go over the boiler and test it thoroughly. We then operated this boiler under 100 lb. pressure for about a year under these conditions, and had a reinspection by the same man and found that it had not deteriorated under these conditions any more than the corresponding deteriorations of a boiler running with the ordinary coal fire. Of course, we had trouble with salt cake subliming and vaporizing and condensing on the boiler and fouling the tubes, but we at this time were not interested so much in this aspect of the case as we were in ascertaining if the boiler would stand up under these conditions.

Having satisfied ourselves absolutely that the boiler would stand up, we next tackled the problem of burning the liquor in the furnace in order to save the heat in the boiler.

Now a few words as to the nature of the residue ob-

tained from evaporating the water from the black liquor. This is a dark-brown plaster or semisolid, according to the temperature. At temperatures of steam it melts forming a sticky, gummy mass, impossible to handle in any known manner. Even in the cold it cannot be chipped, disintegrated, handled or conveyed in any known manner, and two lumps placed one on the other will nevertheless coalesce into one another. It is a most difficult substance to handle. It was thought that if this could be absorbed in sawdust, that we could evaporate the water with furnace gases. We put in a drying tower composed of shelves, blowing the sawdust alternately in and out from shelf to shelf, running the black liquor thereon and passing the flue gases over it from bottom to top. The dried, impregnated sawdust was then carried by conveyors to the furnaces. This worked as long as there was sawdust enough from the sawmill. But there was never sawdust for more than 20 per cent capacity. We then tried hogging wood, but this got us into trouble at once, and it was found that owing to the low absorptive capacity of the hogged wood that it was impossible to build a drying tower strong enough to deal with the resultant sticky mass. We went from 6-in. I-beams to 15-in. I-beams, but found we would twist off the latter almost as rapidly as the former. We even tried using black ash as an absorbent for the black liquor. When it worked the reduction in the furnace was excellent, though it was found the resulting amount of iron in the liquor produced made the problem of settling out of the lime sludge a very difficult one. However, owing to mechanical troubles, this was found, as above stated, absolutely impracticable and had to be abandoned.

We had some time previously tried to atomize this liquid into a hot flame, hoping to evaporate the water from it and have it charred by the time it landed 7 ft. away, but without success, and the reason is very clear, if one considers the difficulty of getting a fine spray with this liquor.

A simple calculation will show that for the evaporation of the water alone, say nothing of charring, the diameter of these droplets could not be over 0.0029 in. if evaporated in gases at 2000 deg. Fahr. traveling a distance of 7 ft., heat abstracted from gases 0.005 in. thickness surrounding the droplets during the entire passage through the furnace, liquor 50 per cent water and temperature 210 deg.

Now, as a matter of fact, this liquor cannot be atomized to this fineness or anywhere near it, so though we started with a good fire we soon put it out by plastering it over with this liquor.

Now, after this drying tower proved such a failure, our minds turned back to our atomizing experiments. If we could only atomize finer and get some additional heat, we figured that it ought to be done this way. There was some chance that by experimenting we might make an improvement in atomization, and it occurred to us that the additional heat might be obtained from radiation. Stefan's law naturally occurred to our minds at this stage of the proceedings, and we at once collected all the data relating thereto to see if we could make a practicable use of the same.

This law is in brief that the heat radiated from one black body to another varies directly as the difference of the fourth powers of the absolute temperature. This may be expressed as follows:

$E = K(T_2^* - T_1^*)$ where E is the total energy radiated and K a constant, T_2 and T_1 being absolute temperatures, of which T_2 is the higher.

It is not our intention in this paper to drag it out to an interminable length by going into the mathematics of this law, which have been so well established that any one interested may refer to the reference given at the end of this paper.

We have, however, calculated certain results and submit these in the forms, viz., the tabulated and the graphical chart. The calculations finally reduce down to the following simple formula:

$$\text{B.t.u. per sq. ft. per min.} = 2.66 \times 10^n (T_2^4 - T_1^4).$$

CALCULATIONS

ASSUMING STEFAN'S LAW FOR BLACK BODIES

English Units $K = 2.66 \times 10^{11}$ B.T.U. per min. per sq. ft.

$$B.T.U. = K (T_g^4 - T_1^4)$$

Case I. $T_1 = 600^\circ \text{ F. abs.}$ T_2 varies

T ₁	T ₂	T ₁ ⁴	T ₂ ⁴	T ₂ ⁴ -T ₁ ⁴	B.T.U.
800°	600°	409×10 ⁹	1295×10 ⁹	279.5×10 ⁹	7.43
1000		100×10 ¹⁰		870.5×10 ⁹	23.15
1200		2075×10 ⁹		194.6×10 ¹⁰	54.80
1400		384×10 ¹⁰		371×10 ¹⁰	98.80
1600		655×10 ¹⁰		642×10 ¹⁰	171
1800		105×10 ¹¹		103.7×10 ¹¹	276
2000		160×10 ¹¹		158.7×10 ¹¹	422
2500		390×10 ¹¹		388.7×10 ¹¹	1034
3000		819×10 ¹¹		808.7×10 ¹¹	2150
3500		150×10 ¹²		150×10 ¹²	3900
4000		256×10 ¹²		256×10 ¹²	6810
4500		400×10 ¹²		400×10 ¹²	10000
5000		625×10 ¹²		625×10 ¹²	16000
5500		915×10 ¹²		915×10 ¹²	24300
6000		130×10 ¹³		130×10 ¹³	34600

CALCULATIONS

ASSUMING DIFFERENT LOWER TEMPERATURES FOR DIFFERENT CASES

Case II, $T = 500^\circ$ abs. Case III, $T_1 = 700^\circ$ abs. Case IV, $T_1 = 800^\circ$ abs.

Case V, $T_1 = 1000^\circ$ abs.

Case II		Case III		Case IV		Case V	
T ₁	B.T.U.	T ₂	B.T.U.	T ₃	B.T.U.	T ₄	B.T.U.
800	9.20	800°	4.5	800°	0	800°	-----
1000	24.90	1000	20.2	1000	15.8	1000	-----
1200	43.50	1200	48.8	1200	44.3	1200	28.6
1400	100.40	1400	95.7	1400	91.2	1400	75.5
1600	172.50	1600	167.9	1600	163	1600	147.5
1800	278	1800	273	1800	268	1800	252.5
2000	424	2000	419	2000	414	2000	399
2500	1034	2500	1030	2500	1027	2500	1001
3000	2150	3000	2147	3000	2143	3000	2125
3500	3990	3500	3985	3500	3980	3500	3970
4000	6810	4000	6810	4000	6810	4000	6900
4500	10900	4500	10900	4500	10900	4500	10880
5000	16600	5000	16600	5000	15600	5000	16600
5500	24300	5300	21300	5500	4300	5300	24300
6000	34600	6000	34600	6000	34600	6000	34600

In order that there may be no mistake as to what radiant heat is I will state that it is the heat which passes from a body of higher temperatures to a body of lower temperature through an intervening gas without heating that gas. Thus the heat of the sun heats the earth without heating the intervening air. The earth in turn heats the air. The so-called steam radiator heats by convection, not by radiation. It must be borne in mind that this is not a simple process of evaporation and that this is not the main object in view. The main object in view is the recovery of the alkali present in the digester liquor and that this must be a reducing process.

This liquor after the water has been evaporated analyzes 45 per cent ash and 55 per cent combustible, which is spoken of in the paper as lignin, though it contains sugars as well as lignin, the approximate formula for which being $C_{10}H_{16}O_{11}$. This so-called lignin contains about 36.2 per cent combined water. Analysis shows that 2 lb. of the 50 per cent liquor contains 1 lb.

water of solution, 0.2 lb. of combined water and 0.35 lb. of carbon, 0.45 lb. of ash. For this amount of liquor 0.14 lb. of salt cake may be added.

The heat required for evaporation and combustion may be calculated to have the following distribution:

B.t.u. required to evaporate 1 lb. water at 212 deg.	= 1052
B.t.u. required to raise this to 1600 deg. Fahr.	788
B.t.u. required to raise combined water to 1600 deg. Fahr	157
B.t.u. to raise products of combustion (12 per cent CO ₂) to 1600 deg. Fahr.	2918
B.t.u. required to melt 0.45 lb. ash in liquor.	164
B.t.u. required to raise 0.45 lb. ash to 2000 deg.	



B.t.u. figuring loss through furnace walls 10 per cent.

Total heat 5865

It will be seen from the above that the heat in the liquor, viz., 5000 B.t.u., falls considerably short of the theoretical heat needed to carry on the reaction, and that it is this deficiency which must be supplied by radiant heat.

On the other hand it will be seen that a part of this heat is available for making steam if a steam boiler is placed in the pathway of the hot gases.

If we reduce the gases from 1600 deg. to 500 deg. we get:

B.t.u. from superheated steam..... 610
 B.t.u. from products of combustion..... 2138

Total B.t.u. available for making steam..2748

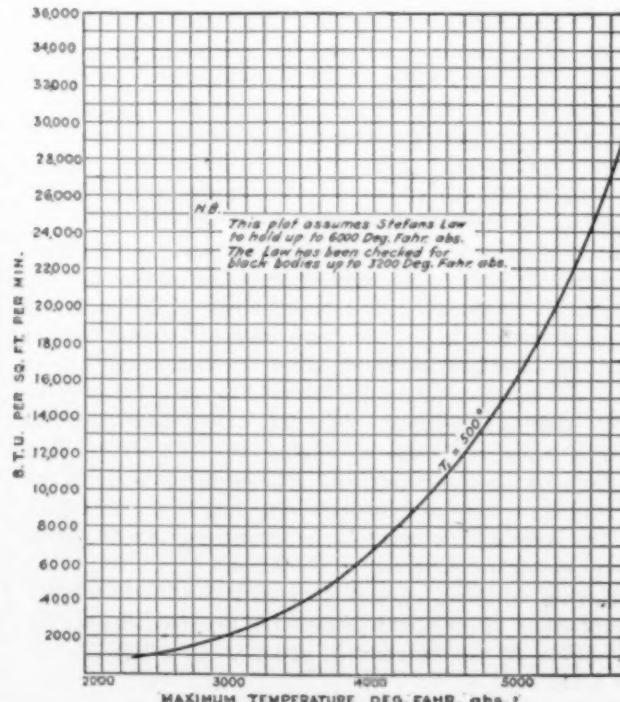


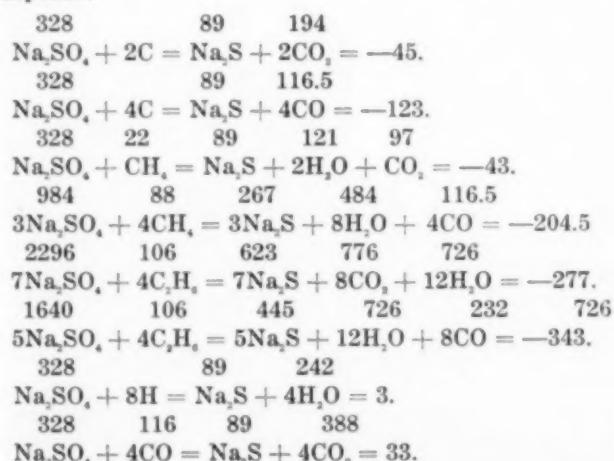
FIG. 1—CALCULATIONS, ASSUMING STEFAN'S LAW

Now we come to the problem of making up the deficiency. There are several ways by which this might be done, but only a few are practicable. If we had plenty of cord wood we could make it up in this way, and, in fact, we did at first. The results, however, were not satisfactory from the reduction side of the case. Coal can be atomized in the furnace and burned, but as all coal contains iron, it is objectionable on account of the difficulty of settling of the alkaline liquors which is occasioned by the iron. Furthermore, the coal contains ash which uses up the alkali, forming silicates and aluminates of soda, etc. It is also not satisfactory from a reduction point of view, as it requires an oxidizing flame.

Atomized crude oil was also tried, and though this gave a very hot flame furnishing the necessary amount of heat, it is not satisfactory from a reduction standpoint. Furthermore, the vaporization of the oil produces a cool zone in the place where it is necessary to have a hot zone tending to chill the smelted effluent.

Producer gas seems at present to be the most satisfactory way of supplying the extra heat needed. This enters the furnace hot and quality and quantity of the gas can be easily regulated. By constantly feeding the producer, we get a gas containing a large quantity of illuminants which are heated to high temperatures upon combustion of the gas and radiate heat to the particles of liquor to be evaporated, and these can be heated to a very high temperature by the burning of the already hot gas furnishing more illuminants.

Now if you will consider the following reactions, I think you will see the utility of this gas for reduction purposes:



The numbers given in the above equations are in large calories per gm. molecular wt. taken.

It will also be seen that in all cases except the last two the reaction is endothermic. In the last two, viz., saltcake and hydrogen, and saltcake and carbon monoxide, the reaction is exothermic. Now if we could have either pure carbon monoxide or pure hydrogen come in contact with molten saltcake, we should have a reducing action which would not chill the molten liquor so as to congeal it.

In order that there may be no misunderstandings, I want to say that the operations mentioned in regard to reduction in this paper must not be considered as taking place on pure sodium sulphate nor should the resulting product be considered as pure sodium sulphide. In every case we have a mixture of several ingredients, viz., sodium carbonate, sodium sulphate, sodium sul-

phide and probably a little sodium oxide. Sodium sulphide pure does not melt at 2000° C. and in order that this should run at ordinary temperatures it must be dissolved in other salts.

Now in the above figures we have figured the saltcake as if all was reduced by the carbon in the lignin liquor. We did this in order to show the distribution of heat and the total heat consumed. As a matter of fact, however, I doubt if very much of this salt is reduced by the carbon of the lignin as the lignin is burning in an oxidizing atmosphere and any sodium sulphide reduced here from contact with the heated carbon would to a large extent be oxidized to sulphate of soda. In fact there is a considerable amount of sulphate of soda found in the smelted effluent of the furnace. The reduction caused by the lignin may be greatly increased by the producer gas. This has been shown many times by stopping temporarily the gas and the liquor and testing the effluent. The reduction of this gas was so marked that many experiments were conducted, the main object being to obtain a better mixture of this gas with the effluent. In all these experiments the reduction was markedly increased but most of them were abandoned owing to mechanical difficulties which developed.

CALCULATED AMOUNT OF COAL TO BE BURNED IN PRODUCER

The question now arises as to the amount of coal necessary to be burned in a producer to furnish the required liquor per ton of pulp produced in the mill. From data obtained we find a coal which analyzes as follows:

	Per cent.
Fixed carbon	53.34
Volatile matter	39.25
Moisture	2.66
Ash	4.75
Total.....	100.00

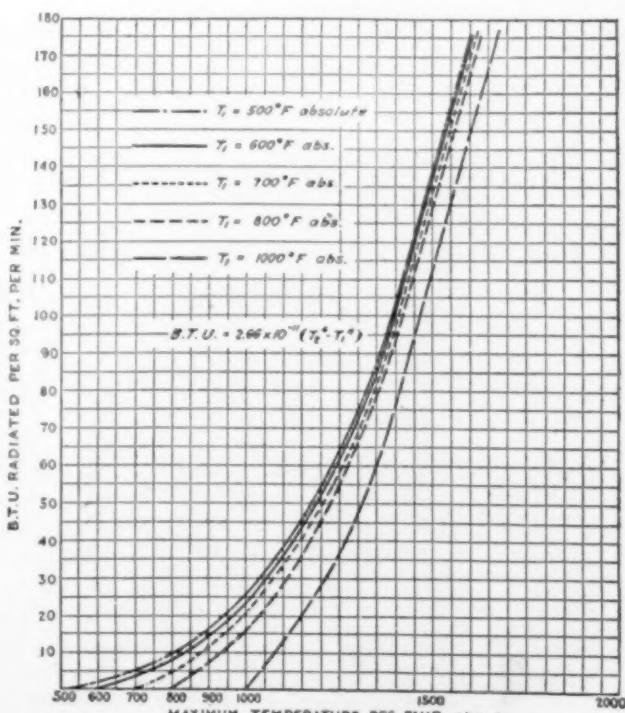


FIG. 2—CALCULATIONS, ASSUMING VARIOUS LOWER TEMPERATURES

and which has an ultimate analysis given as follows:

	Per cent.
Carbon	73.11
Hydrogen	5.88
Nitrogen	2.10
Oxygen	9.24
Moisture	2.66
Ash	4.28
Sulphur	1.73

This will give a producer gas which analyzes as follows:

	By Vol.	By Weight.
Carbon dioxide	3.9	7.32
Ethylene	3.2	3.75
Oxygen	0.1	0.13
Carbon monoxide	24.6	28.86
Methane	3.8	2.62
Hydrogen	17.7	1.51
Nitrogen	46.7	55.81
	100	100

If we assume the gas comes from the producer at 1200° F. and that we burn it with the theoretical amount of air we find the following amounts and distribution of heat for 100 lb. of gas:

Heat of combustion of 3.75 lb. ethylene	77,560
Heat of combustion of 28.86 lb. carbon monoxide	126,200
Heat of combustion of 2.62 lb. methane	56,190
Heat of combustion of 1.51 lb. hydrogen	79,230
Total	339,180
Sensible heat 7.32 lb. carbon dioxide	2,228
Sensible heat 3.75 lb. ethylene	1,820
Sensible heat 0.13 oxygen	34
Sensible heat 28.86 carbon monoxide	8,533
Sensible heat 2.62 methane	1,869
Sensible heat 1.51 hydrogen	6,494
Sensible heat 55.81 nitrogen	16,500
Total	376,658

Now the simplest method of getting the heat radiated is to find the heat leaving in the products of combustion and subtract this from the total heat.

In doing this the following formulas are used:

$$\begin{aligned}
 &(2405+0.000119t) = \text{B.T.U. for 1 lb. N.} \\
 &(0.19+0.00006t) = \text{B.T.U. for CO}_2 \\
 &(0.2104+0.000187t) = \text{B.T.U. for 1 lb. O.} \\
 &(0.2405+0.000119t) = \text{B.T.U. for 1 lb. CO.} \\
 &(0.42+0.000103t) = \text{B.T.U. for 1 lb. steam.}
 \end{aligned}$$

Now if we assume that owing to radiation and convection the gases are reduced to 1600° F. going over the bridge wall we have a basis for getting the heat in the products of combustion. A simple calculation shows that for every 100 lb. of gas entering the furnace we have a total of 327 lb. going over bridge wall distributed as follows:

$$\begin{aligned}
 &174.48 \text{ lb. of nitrogen from air} \\
 &55.81 \text{ lb. of nitrogen from producer} \\
 \hline
 &230.29 \text{ total nitrogen}
 \end{aligned}$$

11.79 lb. CO ₂ from ethylene
45.97 lb. CO ₂ from carbon monoxide
7.20 lb. CO ₂ from methane
7.32 lb. CO ₂ from producer

72.28 lb. total CO ₂
Total of 327 lb. of gases going over bridge wall for 100 lb. of producer gas.
4.93 lb. steam from ethylene
5.89 lb. steam from methane
13.59 lb. steam from hydrogen

$$24.42 \text{ total lb. steam.}$$

Now if we calculate the heat in these given amounts of products of combustion we find we have:

	B.T.U.
Sensible heat of above steam at 1600° F.	19,260
Heat in 230.29 lb. nitrogen at 1600° F.	95,610
Heat in 72.28 lb. carbon dioxide at 1600° F.	23,080

Total heat in products of combustion of 100 lb. of gas at 1600° F. going over bridge wall	137,950
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The excess of B.T.U. in the gases generated over those contained in the products of combustion at 1600° F. is found by subtracting 137,950 from 376,658 which gives us 238,708 B.T.U. for 100 lb. of producer gas available as radiant heat to heat the particles of liquor.

Calculation from the ultimate analysis of the coal and the analysis of the gas show 1 lb. of carbon produces 3.729 lb. of gas, or that for every pound of coal burned in producer 14,050 B.T.U. are liberated. Of course all this heat does not come from the coal, but part comes from the steam blown into the producer. Assuming a loss here also of 10 per cent through furnace walls, we have a loss of 1405 B.T.U. to take from the heat of radiation, neglecting heat losses from furnace. We find that we get 2387 B.T.U. per pound of gas to be supplied by radiation and convection to liquor and from this we get B.T.U. per pound of coal, 8851. Subtracting from the latter the 10 per cent heat losses for furnace, 1405, we get 7446 B.T.U. to be applied to making up the 865 B.T.U. deficiency not supplied by the heat in the lignin.

Now let us take as a unit a mill producing 100 tons a day of Kraft pulp.

Wood for making such pulp varies all the way from 45 to 52 per cent cellulose according to kind used and location grown. Let us assume a pulp containing 48 per cent cellulose and 52 per cent lignin. Then a unit of 100 tons pulp would have a content of 108 tons of lignin in the black liquor.

As the dried liquor is 45 per cent ash we find that our 100 tons of lignin makes 197 tons of dried black liquor. Then we have 394,000 of solid matter or 788,000 lb. of 50 per cent liquor.

Multiplying 394,000 by 865 and dividing by 7446 we find that we must have at least a producer capacity of 45,760 lb. per day per 100 tons of pulp. Of course there should be some leeway for poor coal variations in strength of liquor.

As a matter of fact we have found a 20 per cent margin above this not excessive when we consider the troubles eliminated by not running close to the theoretical point where any of the many variables tend to

upset the operation even to the extent of clogging the furnace.

TANGIBLE RESULTS FROM ELIMINATION OF INCINERATOR

As a result, however, of the above process we have been enabled to produce over 1600 horse-power from our liquor in addition to recovering the heat generated in the gas producer. We saved all our hospital bills and damages arising from explosions, we reduced the repair bills in the furnaces enormously, we saved all the repairs on incinerator and disk evaporators and the power required to run same, we saved about 60 men's labor in various departments and, above all, got an even, uniform production of quality never obtained before. In addition to the above it alone was the means of increasing the production many times.

KEEPING BOILER TUBES CLEAN

We have already mentioned that the boiler tubes in the preliminary experiments got dirty from sublimed saltcake and carbonate of soda. The keeping of the tubes clean proved to be a much more difficult problem than we first thought. The sublimed saltcake first deposits on the tube as a powder, but if not removed the additional saltcake soon smelts the whole to a continuous lump almost impossible to remove. The obvious remedy was to blow the tubes often enough to keep this powder from accumulating on the tubes, but how to do this without affecting the operation of the furnaces was a problem. I might also add it is still a problem, for though we have a workable proposition I think there is still a large chance for improvement. If we opened the clean-out doors we spoiled our draft and consequently had to shut the furnace down. We tried automatic blowing, but these blowers would burn off in the vaporized alkali or plug up so we could do nothing. We even had doors made with a hole covered by a small door opposite each tube, but these were unsatisfactory in that we were blowing from the wrong end and the air or steam did not have force enough by the time it got to the fire end of the tube to remove the accumulation of salt and alkali. We finally evolved a scheme by rebuilding the back of the furnaces where we could have a slot on top covered by covers and a rake attachment locating the tubes horizontally. The tube blower was also graduated by a ratchet attachment to locate the tubes vertically. By this means the tube of each boiler is blown twice a shift. Each blowing takes twenty minutes and we run three shifts; it will be seen that two hours are required for each furnace for every twenty-four hours of operation.

ADDITION OF SALTCAKE

The next problem was the constant addition of saltcake in the required quantities to the liquor. We first tried putting the saltcake in the back of the furnace through a tube supplied with saltcake by means of a conveyor. This did not give us the results desired, inasmuch as this was not properly mixed with the liquor, and consequently a great deal passed through the furnace unchanged. In other words, our reduction to Na_2S was small and the desired liquor was not obtained. The next step was to put a horizontal agitating tank over each furnace and mixing the liquor and saltcake therein and supplying each furnace separately according to its consumption. This worked fairly well.

The main objections to this was the increase in the amount of labor required and the clogging of the pipes with saltcake when it was necessary to close a valve. We were quite successful in the scheme described in U. S. Patent 1,130,317, Mar. 2, 1915, not described here on account of taking up too much space.

We finally evolved a scheme by which we put saltcake in a hopper from which it was carried to a grinder, elevated to a rotary screen and sifted, the fine particles going to a mixing tank and the coarse particles being returned to the grinder to be reground. The mixer tank was supplied with liquor from the storage tank installed to hold the evaporated liquor, and powdered saltcake added by calibrated diaphragms so that a given amount of saltcake was added for a given amount of liquor. The mixture was pumped to the furnaces through a pipe in which a very high velocity was maintained and the liquor not used in the furnaces was returned to the mixing tank also at a high velocity. The object of having a high velocity in the pipes is to prevent the saltcake, which is only slightly soluble in liquor of this concentration, from settling out. Special valves were designed on the outlets of this pipe so that they could be cleaned without stopping the operation and they were so set into the line as to prevent forming a pocket on the take-off. In addition to the above, many contrivances were adopted for handling this liquor, but as to describe them would stretch this paper to undue length I must omit them.

SETTING AND RESETTING BOILERS

Now, having described the amount of heat coming from the flue gases of the furnaces, it might be well to state the method of recovering the heat contained therein. Experiment had convinced us that the horizontal return tubular boiler was best adapted to our needs on account of the comparative ease, as compared with other types of boilers, by which the saltcake and soda could be removed from the tubes. This we set up following the standard accepted boiler setting. This was found to be a great mistake and the settings had to be entirely changed to meet the new conditions imposed on them. In explanation I wish to say that though saltcake, soda and sulphide of soda vaporize at high temperatures they may be sublimed at 1200° F. in a current of furnace gases. Now the shell of the boiler acts as a condenser and the hot molten alkali condensed forward of the peak in the boiler setting flowed forward into the furnace. But unfortunately all the vaporized alkali was not removed here, but a considerable amount was condensed on the boiler back of the peak and this either accumulated as a lake of molten alkali or gradually solidified or ran out of the clean-out door onto the blow-off pipes or the cement floor. I have at times seen streams of molten alkali as large as my arm so run out of these clean-out doors.

These furnaces had all to be rebuilt with a continuous slope from the clean-out doors to the furnace. Even the whole length of the shell of the boiler was insufficient to condense all the sublimed alkali and this would accumulate in the tubes at first as a powder, but if the tubes were allowed to get too dirty the powder being a nonconductor of heat insulated the boiler tubes and the next accumulation of sublimated soda landed in the tubes in a melted condition cementing this powder to a hard mass. Many and various were the schemes

tried to get over this trouble, and we are still experimenting.

DISSOLVING TANK LIQUOR

As previously stated, the smelt runs into the dissolving tank where it is dissolved in the weak alkali coming from the alkali room. Owing to the greater efficiency of reduction we obtained a dissolving tank liquor much stronger in sulphide content than ever obtained before. Owing to the elimination of the incinerator and the intermediate black ash process the sludge in the dissolving tanks is very much reduced and the pieces of half brick, stones, etc., are reduced to a minimum; thus the constant repairs of agitator arms, etc., were eliminated.

FLUE GASES

The gases from the smelting furnaces contain considerable quantities of alkali irrespective of whether the old or the new process just described is used. This alkali is in such a fine state of subdivision that it is practically impossible to remove it by any of the ordinary means. These gases were run through a tower filled with atomizers, filling the tower with a dense fog and yet the particles were so fine that they would not be precipitated. We finally decided to experiment with the Cottrell Process and made arrangements for the same with the Western Precipitator Co. Owing to the great quantities of moisture in our flue gases we were not very successful at first, inasmuch as the moist precipitate would short-circuit the apparatus. But after making many changes we finally evolved a modification of this process which works finely. This not only prevents a public nuisance but it yields large dividends from the saving of this precipitate.

FILTRATION OF DISSOLVING TANK LIQUOR

As stated before, the dissolving tank contains many impurities among which is carbon, furnace linings, iron sulphide, etc., etc. Now the treatment of this liquor depends on the question of whether or not you intend to recover your lime. If the lime is not to be recovered this liquor can be pumped directly to the causticizing tanks. If, however, it is the intention to recover the lime it is necessary to filter this liquor from all the suspended matter, otherwise every time the lime was recovered there would be an addition of these impurities which would make the recovery impracticable. We have found that the best way to handle this is through a filter press. Here, however, we run up against a great difficulty, though this first made itself apparent in the causticizing operation to be described later on. The canvas used in the filter press does not stand alkali and required renewal so often that it was a source of considerable expense. This difficulty was partially overcome by treating it with a special rubber solution, depositing the rubber on the canvas threads and yet leaving the cloth porous. There is still chance for improvement here. The liquor after being filtered is sent to the alkali room.

ALKALI ROOM

In this room the liquor from the dissolving tank is causticized. This room consists of a large number of settling tanks fitted with siphons, lime, baskets, agitators and steam pipes for blowing in live steam. Here the liquor is tested and the calculated amount of lime added to the slacking baskets, steam blown in and the

tank agitated, after which the precipitated carbonate of lime is allowed to settle. The supernatant liquor is siphoned off and weak liquor added from a previous washing and the operation repeated. Finally, the fourth washing is done with water after which the sludge is sluiced. As will be seen this process involves a large installation and requires a considerable amount of steam as well as considerable amount of time. Now the time factor is important inasmuch as if anything happens so that you become short of cooking liquor the digester plant has to shut down more or less waiting for these tanks to settle. Furthermore, the very nature of the process is such that it invites waste by either not washing properly due to neglecting one washing or due to incomplete settling on account of trying to catch up with the digesters, or losses may occur easily by intentional or unintentional manipulation of the labor employed.

In order to eliminate these wastes a filter press was installed which enables us to dispense with the settling and leaves many of these tanks available for storage of liquor. The lime sludge can be washed in the filter press with much less water than is used in the decanting or settling process and may be washed much freer from alkali. Furthermore, if the dissolving tank liquor has been filtered the lime sludge is in a condition for recovery of the lime. This operation allows us to make a stronger alkali solution than we otherwise could, and consequently we can use more black liquor as a filter in our digesters later on. This also means less evaporation later on.

RECOVERY OF LIME SLUDGE

We have experimented quite successfully on the recovery of the lime sludge, but up to the present have not put in an industrial plant. As this is not operating on a large scale I will not go into this here, but may in a future paper show how this is done. The method which gives the greatest promise is the electric furnace method, whereby we get pure CO₂ and recover our lime. We have installed a large experimental electric furnace with this end in view and expect to work it when our water-power development is completed.

DIGESTER HOUSE

The alkali from the filter press goes to storage tanks and thence to the digesters already filled with chips, where it is mixed with a certain amount of black liquor (used as a filler). The digester is steamed and cooked in the usual way. We however, made one very important change here. Instead of blowing relief into water to heat it we constructed a condenser and condensed the relief after first having separated it from the liquor which is contained.

There were three objects in view here. First, there was a limitation placed on the use of our pulp for many purposes, owing to the odor in bags used for holding flour, etc. My experiments had convinced me that a lot of this odor came from the use of this wash water. To get rid of this odor was the primary object but of course we wanted to save the heat.

Turpentine Recovery.—Our experiments had also shown that this relief contained large quantities of turpentine which, with the exception of the odor, tested equal to the best gum turpentine obtainable and far superior to wood turpentine. We consequently constructed, in addition to the condenser and separator

plant previously mentioned, a turpentine plant in which we separated the crude turpentine, made refined turpentine and finally a plant for deodorizing it from the mercaptan smells which accompany it. We have not been able to completely remove the odor, but have so far succeeded that we are enabled to sell our whole production at good prices.

VOMIT STACK GASES

After a digester is cooked the charge is blown into tanks to receive the pulp and liquor and the liberated steam is allowed to escape through a vomit stack. A calculation showed that there might at times be as much as 18,000 lb. of steam liberated in the course of a five-minute blow. Now here is over 20,000,000 B.T.U. per blow going to waste.

To save this we designed special condensers to condense this steam and heat the condensing water so that it could be used for washing the pulp.

VOMIT STACK PULP

Experiments had also shown that this vast amount of steam carried along with it a certain amount of pulp which except for these experiments would have entirely escaped our notice. This pulp, however, which is of the finest quality and should be saved for its own value, must be removed from the vomit stack steam before it enters the condenser, otherwise the plugging of the condenser is liable to follow. To do this we designed a special separating device somewhat on the principle of the cyclone so commonly used in separating shavings from air. This, however, was made with a pipe in the center which was closed at the bottom and had holes in it near the top for the outlet of the escaping steam. The steam was blown in at a tangent to the separator and circulated spirally up the separator, plastering the pulp over the side by its centrifugal force while the steam, now freed from pulp, passed to the condenser. Devices were also arranged for washing this plastered pulp from the sides as soon as the blow was completed.

The above not only enabled us to save an appreciable quantity of pulp but furnished us with immense amounts of hot water practically free of cost, enabling us to make a better and cleaner pulp.

WASH ROOM

The pulp from the digester is washed in the usual manner, though even here we have devised a machine on the counter-current principles of washing which looks as if it would revolutionize the whole washing end of the business. At present it is too soon to say much about this.

LIQUOR FROM WASH ROOM

This liquor instead of going direct to the evaporators goes to a filter press, and it is found that we obtain a considerable saving in pulp. Not only this, but the removal of this pulp from the liquor makes a direct saving, not due to the pulp, but an indirect saving which is even of far greater importance. I refer to the trouble eliminated in the evaporator room by being freed from the accumulation of pulp in the last effort which seriously interferes with evaporation.

We have now completed our cycle, being back where we started. In the foregoing we have not taken into consideration all the departments of the mill. Many of these are undergoing changes, but enough has been

said to show that the chemical engineer can play a most important part in the renovation of this kind of mill at least. My own personal opinion is that the chemical engineer has a great opportunity in any mill involving a chemical process. In closing I may say that the average manufacturer considers the chemist and the chemical engineer as non-productive labor and classes them with the office help. As a matter of fact, the chemical engineer can probably not only save him more money than any other department of his mill but also produce him more money.

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Chemists in War Service.—The American Chemical Society points out the advisability of following the lead of our Allies in assigning technically trained chemists to chemical service. Lacking an exemption of any group of men as a class, it is unofficially recommended that chemists of military age selected by draft and accepted for service should submit to their local boards a certificate from their employers or college as to their education and nature of present occupation, together with a request that they be allowed to continue in chemical work, either in private plants or in the military service. In any case, the secretary of the society should be promptly notified by members of any change in enrollment.

Operating Details of Zinc Retort Furnaces

By Edward Mackay Johnson

Superintendent Eagle Picher Lead Co.

LIGHT, VENTILATION AND SANITATION

Light, ventilation and sanitation all have at least an indirect bearing upon the recovery of zinc, and in designing a plant, or even in one already in operation, they should receive due consideration. While most of the furnace men do not work over five or six hours per shift as a rule, the rapidity with which they make up and charge a furnace has a decided effect upon the recovery of zinc. The men can do just as good, and at the same time faster work, provided their working conditions are favorable.

Work on the furnaces in the summer time is very hot and trying on the men at the best, and any relief in the way of improved conditions will not only add to their comfort, but will pay for the cost, both in the increased recovery of zinc and in retaining a more efficient organization. Considerable advancement has been made along these lines in the past two or three years by blowing fresh, cool air upon the men while at work during the hot months of summer. A number of the plants have also constructed convenient wash rooms. It is unfortunate, however, that the men in a good many cases have not shown their appreciation of the companies' endeavors to improve their conditions.

FURNACE WORK AND TOOLS—NATURAL GAS FURNACE

Head Charger.—The first duty of the head charger upon coming to work is to mark any bad retorts in the furnace. He then assists in drawing the first four sections of the furnace. As soon as the draw-car and blow-out shield (through which also the retorts have been "bumped") are out of the way, the charger, with a specially constructed scoop (Fig. 1), commences



FIG. 1—CHARGING SCOOP

charging the retorts with material from the charge-car, which travels on a near-by track parallel with the furnace. He should fill the retort from back to front without leaving any "nests" in the charge. Each retort should be "spiced" as soon as charged by inserting a small iron rod along the top of the charge to prevent the charge from blowing out. Each retort should be examined before recharging to see that it is neither cracked nor has a hole in it. The head charger and second charger work in turn, charging five retorts apiece as a rule. After the furnace is completely charged, the head charger cuts out the bad retorts, helps pull them out, and put in new ones. He should also look after changing any bad plates or pillars.

Second Charger.—The first duty of this man is to oversee and help to turn and mix the blue powder with the proper amount of coal and water, being careful to obtain a thorough mix. He now helps draw the first four sections of the furnace and assists in bumping out the retorts in the first section. He then alternates with the head charger in charging the furnace, and helps the

stamper (the man behind the car) patch up any holes in the furnace as they go along. As the new retorts are placed, he stamps them with furnace mud.

Man Behind the Charge Car, or "Stamper."—While the first four sections of the furnace are being drawn, the stamper helps in any way he can, pushing the draw-car along, etc., and then he draws the remainder of the furnace down to the blue powder. He then works behind the charge-car, laying the condensers over by the furnace so that the "loamer," or man behind car, can place them upon the castings. The stamper now sets the condensers by placing the butt about an inch into the mouth of the retort, resting the small end or mouth of the condenser upon the "grasshopper" (a small casting somewhat resembling the leg of a grasshopper), adjusting the condenser in its proper plane with respect to the retort, and with the bottom of the condenser practically horizontal. Another important duty of the stamper, and the one from which he gets his name, is to stamp the furnace mud into the openings left wherever new retorts are put in. The stamping tool (Fig. 2) must be hot to prevent the clay from adhering to it.



FIG. 2—STAMPING TOOL

He also shovels one-half of any charge spilled during charging back into the charge-car. He goes ahead and draws the blue powder as soon as it is ready. With the aid of the "loamer" he scrapes off the luteing material from the castings, and cleans up the floor between the track and furnace.

Man Behind the Car, or "Loamer."—The loamer's duties consist of the following: He helps the stamper draw the furnace from the fourth section to the blue powder; places the condensers upon the castings; closes the spaces between the retorts and condensers with loam as the stamper adjusts them to position. The loam usually consists of about five parts coking coal, one part dirt and one part residue, mixed together and moistened with water. While loaming-up he also closes the mouth of the condensers with "stuffing," which may be non-cooking coal or samplings from the mouth of the retort mixed with furnace tops. The loamer also helps the stamper scrape off the castings and clean up the floor between the furnace and charge-car track.

Chiseler.—This workman helps to turn the blue powder; chisels and pries the condenser loose from the retort with a chisel bar (Fig. 3); chips that part of



FIG. 3—CHISEL BAR

the broken condenser which contains material valuable enough to be retreated, breaks it up fine and turns it into the blue powder. He also cleans up the floor on the outside of the track and puts in six pans. He gets the clay from the pottery and wheels in the coal for the blue powder; hooks the burnt clay out from between the retorts that are to be changed; carries the pole to

take the new retorts from the preheating kilns to the furnace, and shovels one-third of the blue powder over by the furnace for the charges.

Blow-out.—The first duty of the "blow-out" is to clean the floor and dump the furnace pans. He then takes down the condensers as the chiseler cuts them loose, and samples the mouth of the retort—*i.e.*, he rakes out any oxide of zinc or the richest of the residue, which is nearly always at the mouth of the retort. He scrapes the samplings from off the castings upon the furnace pans, which material goes to the blue powder for the next shift. He pulls these pans out and sweeps up the floor as he goes along, leaving open the channels to the cellar.

He now proceeds to "blow out" the retorts by means of an iron pipe (Fig. 4) drawn to a point and perforated



FIG. 4—BLOW OUT HOSE AND PIPE

with small holes at the end, through which a spray of water under pressure issues. The pipe is inserted through the blow-out shield to the end of the retort with a firm, steady push. As the spray of water enters the hot residue, the rapid generation of steam causes an explosion on the inside of the retort, which ejects the residue from the retort against the shield, whence it falls into the cellar below. The blow-out also puts in the last four pans, shovels one-third of the blue powder over to a convenient place for the chargers, helps the bumper carry the retorts from and to the furnace by means of the goose neck (Fig. 5). He also helps to



FIG. 5—GOOSE NECK OR RETORT CARRIER

clean up the clay from in front of the furnace after the retorts are charged.

Bumper.—The "bumper" helps turn the blue powder, bumps the mouth of the retort free from any burnt loam, etc., and with the same tool (illustrated in Fig. 6)



FIG. 6—BUMPING TOOL

rakes any slag or residue that remains in the retort after blowing out. He works through a slot in the same shield used by the blow-out, alternating with the latter in his work. He cleans the castings after bumping with a hoe (Fig. 7), puts in the second six pans, shovels



FIG. 7—TOOL FOR RAKING OFF THE CASTING

over one-third of the blue powder to the charges, helps take out broken retorts and put in the new ones, and helps clean up clay, etc., after the retorts are all changed.

Condenser Boy.—The duties of the "connie" boy con-

sist in scratching the blue powder and oxide of zinc from the inside of the condenser with an iron button riveted to the end of a light iron rod (Fig. 8). He also



FIG. 8—SCRATCHER BUTTON

bumps off any zinc crust or burnt loam from the outside of the butt of the condenser (Fig. 9), keeps the charge shoveled down in the charge car, and sweeps up the furnace floor outside the charge-car track. After the



FIG. 9—CONNIE BOY'S BUMPER

furnace is charged he keeps the condensers spiced up by introducing through the top of the stuffing a small iron rod drawn to a point. If, after spicing, a flame shows at the butt of the condenser, he "patches up" or throws fresh loam around the place burning out. He screens the samplings and gets the stuffing ready. One condenser boy attends to two furnaces or one block after 11 a. m. The condenser boy as a rule uses the same buttons that the metal drawer drew the furnace with.



FIG. 10—TOOL FOR HANDLING CONDENSER

Metal Drawer.—The metal drawer, as the name implies, draws the zinc and scratches the oxide of zinc and blue powder from the condenser into a ladle by means of the scratcher button (Fig. 8). In the West he commences to draw the blue powder about 3.30 p. m., finishing about 4.30 p. m. At 4.45 p. m. he commences at the first section of the furnace and draws the charge through to the blue powder, finishing about 7.30 p. m. He makes the second draw in the same way, commencing about midnight and finishing about 3 a. m. The third or morning draw is made by the "half-shifters." The metal drawer should scratch the condenser clean, but should not pull any more hot residue (or "fire") from the mouth of the retort than is necessary to keep the zinc from freezing in the ladle. This should be specially guarded against if the ore carries much lead or iron, as these elements would then be unnecessarily increased in the spelter.

Stuffer.—As fast as the condensers are drawn, the "stuffer" stuffs and lights them, cleans up the scrap and piles the metal.



FIG. 11—TOOL FOR SAMPLING MOUTH OF RETORT

Day Fireman.—The day fireman has general supervision over his block and its workmen. He comes to work about 3.30 a. m. with the half-shifters, or the men who make up the furnaces. In addition to overseeing the work he works over the blow-holes and cleans out bad retorts that appear during his shift. His most important duty, of course, is the actual firing of the block. He therefore has to regulate the supply of air and gas by means of the main air gate and gas valve, and the small air "shievers" on the furnace.

It is almost impossible to describe the actual process of firing, and only a general idea can be given. The method of firing varies not only for different ores, but sometimes on the same ore at different plants. Assume that the furnace is practically worked off, and is at the critical temperature which the retorts will stand. If the night fireman has not already done so, the day fireman will somewhat reduce the air on the whole furnace as soon as he comes on duty by means of the main air gate, and if any sections of the furnace appear to be too hot he will also close the small shievers at those particular places. As the furnace is drawn, he "cuts-in" these shievers behind the draw-car, which operation necessitates reducing the volume of gas entering the furnace by means of the main gas valve. The small gas valves on the furnace are seldom used. As the furnace is charged the fireman opens up these shievers behind the charge-car, thereby burning the gas closer and more rapidly heating that part of the furnace which has been charged.

It is at this point that the firing may vary. In some cases the shievers are opened rather wide, in order to heat the charge rapidly and obtain a heavy flame at the mouth of the condensers in a short time, then "cutting-in" the shievers sufficient to properly regulate or settle this down. In some cases the shievers behind the charge-car are not opened so wide, thereby bringing the heat up more gradually, not permitting the heavy flame to appear at the mouth of the condensers. The main idea in either case is to so regulate the amount of air and gas entering the furnace to get the latter permanently adjusted for the shift, at the same time increasing the heat of the charge so that it is sufficiently worked off in the allotted time. The method of firing an ore depends on whether it is hard or soft, or gives up its zinc with difficulty or with ease.

In either case the day fireman usually has the furnace "settled down" between noon and 2 p. m., according to the nature of the ore and the time the men start and finish making up the furnace. After the furnace is settled down, the small shievers are not disturbed much. The furnace is kept gradually "coming" by means of opening the main air and gas valves a little from time to time as needed.

Night Fireman.—As a rule the night fireman simply continues to keep the furnace "coming" as above, or he may also open up the small shievers a little, his main object being to have the furnace (or at least the first four or five sections) so fired that very little flame is showing at the mouth of the condensers by the time the men come to work in the morning, which is about 4 o'clock.

In addition to firing the block, he oversees the metal drawing, stuffing the condensers, patching up and splicing, and cleaning out any bad retorts that may show up.

COAL FIELD FURNACES

Hegeler Type.—As this furnace is charged from end to end, the same as in the gas-fired type, the furnace work and tools are very similar, so far as the writer's experience goes. The principles of firing are also essentially the same.

The main feature of this type of furnace is that the artificial gas generated from coal by means of a producer passes directly into one end of the furnace and out at the other without any regeneration, the waste

heat being conducted under boilers at the end of the furnaces.

Neureuther Type.—There does not exist enough difference between the tools used by the men in making up this type of furnace and those used on the natural gas furnace to warrant further description. The details of the work are also practically the same, but owing to the fact that the whole bottom row of retorts is charged at one time, working from the bottom row to the top row, the general system varies somewhat.

In making up a furnace of 400 retorts it is divided into four machines, each of 100 retorts, and a crew of three men. Each crew makes up its part of the furnace practically independently of the other crews. In this type of furnace the retorts are charged first instead of after charging. The furnace, instead of being drawn from end to end in the morning by two half-shifters using a draw-car, is drawn by all of the half-shifters working at the same time. Hand ladies are used to make this draw. The furnace is therefore quickly drawn, requiring only ten or fifteen minutes. In this type of furnace instead of charging from cars the mix of ore and coal is strung along in front of and parallel with the furnace. While the residues are sometimes raked out of the retorts in the gas field, in this type of furnace they are always raked out regardless of the kind of ore smelted.

The foregoing practically covers the essential variations in the work upon that type of furnace which is charged and worked off from end to end, and on one that is charged from row to row, and the whole furnace worked off at the same time.

Henryetta, Okla.

The Action of Aluminium Chloride Upon Solvent Naphtha¹

By Robert J. Moore and Gustav Egloff

The following paper is the application of information obtained in a previous work² on pure aromatic compounds to commercial sources of aromatics. The first paper dealt with the action of aluminium chloride upon pure benzene, toluene, xylenes, cumene and cymene. The starting oil used in the following work was a commercial solvent naphtha derived from the thermal decomposition of coal.

SOLVENT NAPHTHA USED

The solvent naphtha used in these experiments was the usual commercial product of approximately 65 to 70 per cent of xylenes and contained ethyl benzene, trimethyl benzenes and higher derivatives of benzene, traces of unsaturateds and paraffins with about two per cent of naphthalene and naphthalene derivatives.

DISTILLATION ANALYSIS

Specific gravity 0.868 at 15.5 deg. C.

The distillation was conducted in a standard 100 c.c. Engler flask.

Temperature Deg. C.	Per Cent by Volume 1st drop
134.8	0.6
135.0	47.3
140.0	79.4
145.0	85.6
150.0	93.0
160.0	97.7
170.0	99.1
180.0	
181.0	Dry Point

¹A paper read before the Industrial Section of the American Chemical Society at the Spring meeting in Kansas City, Mo., April 14, 1917.

²This journal, vol. XVI, 1917, Moore and Egloff.

Upon sulphuric acid treatment a lemon color was noted in the acid layer.

Experimental Procedure

The formation of benzene and toluene from solvent naphtha may be accomplished by the action of anhydrous aluminium chloride or by generating the aluminium chloride within the body of the liquid by passing hydrogen chloride gas over aluminium powder or filings in the presence of mercuric chloride. The formation of aluminium chloride within the body of the oil by passing hydrogen chloride over aluminium is enormously increased by the addition of a small amount of mercuric chloride which seems to be catalytic in its action.

Both methods of using aluminium chloride were tried in these experiments. In the anhydrous aluminium chloride experiment a charge of 5 per cent by weight of aluminium chloride was added to one liter of solvent naphtha. The distillation of the solvent naphtha was conducted in a round bottom flask of two liters capacity, with a Hempel column to which was attached a 24-in. Liebig condenser. The distillation was conducted so that in a 24-hour run 78.1 per cent of the liquid distilled over. During the distillation copious volumes of hydrogen chloride came over with some of the volatile aluminium chloride, which in part clogged the condenser tube, and a small quantity also separated out in the bottom of the receiving flask. The distillate was neutralized with a 10 per cent sodium hydroxide solution, washed and dried over fused calcium chloride. The residue in the flask upon cooling solidified in part to a heavy black tar, with a layer of lemon colored light oil upon the surface of the tar. This residue was shaken with sodium hydroxide and filtered free of aluminium chloride compounds of some of the hydrocarbons present and free carbon. The oil layer was separated, washed and dried. The dried oil was analyzed for its benzene and toluene content by a method devised by Rittman, Twomey and Egloff.¹

In forming aluminium chloride within the body of the oil by the action of dry hydrogen chloride gas upon aluminium powder or shavings in the presence of a trace of mercuric chloride, a charge of one liter of solvent naphtha was used in the same flask as in the above experiment with a slight modification later described. One per cent by weight of powdered aluminium was added to the liquid and 0.1 per cent of mercuric chloride. A glass tube was passed through a hole in the cork extending to the bottom of the flask and attached to the hydrogen chloride generator. The hydrogen chloride was generated in a Freas apparatus by dropping conc. sulphuric acid of 1.84 specific gravity upon ammonium chloride. The gas was washed and regulated by a Dreschel wash bottle containing conc. sulphuric acid. The formation of aluminium chloride can readily be noted by a reddish flecking upon the sides of the flask. This reddish liquid soon colors the whole mass of solvent naphtha to a deep red, increasing toward a blackish looking mass.

The solvent naphtha is best added to the aluminium in the flask, covering it and then adding the mercuric chloride. The distillation was carried on over a period of twenty-four hours and yielded a distillate of 82.3

Analytical Data

	Anhydrous AlCl ₃	Generated AlCl ₃	Anhydrous AlCl ₃ on Pure Xylenes		Temperature and Pressure 150 lbs. on Solvent Naphtha 750° 800°C 0.940 0.989
			Recovered oil	Per cent of recovered oil	
Recovered oil	0.870	0.872	78.1	82.3	97.6 51.6 37.3
Per cent benzene in recovered oil	1.9			1.5	5.8 19.1 42.5
Per cent toluene in recovered oil	17.9			17.6	19.5 39.9 17.3
Per cent of benzene basis of original oil				1.5	
Per cent of toluene basis of original oil				1.9	5.6 9.8 15.9
Per cent of benzene basis of original oil	13.9			14.5	19.0 20.6 6.5

per cent of the initial charge of 1 liter. The distillate and residue were neutralized, washed and dried. The method of analysis of the oil for its benzene and toluene content has already been referred to.

The percentage yields of benzene and toluene by the two methods of using aluminium chloride are not markedly different so as to state definitely any advantage of one over the other as to yields. The percentage yield of toluene is approximately 25 per cent less when using solvent naphtha in comparison to pure xylenes. As has been shown in a previous communication² this would indicate less susceptibility of benzene and toluene formation under the conditions of the experiment from higher derivatives of benzene than xylenes. A comparison of the data of aluminium chloride treatment of solvent naphtha with thermal and pressure decomposition indicates that the cracking of solvent naphtha under temperature and pressure yields greater percentages of benzene and toluene as shown in above table.

Summary

1. From the results of a research on pure aromatic compounds with aluminium chloride, a commercial oil, solvent naphtha, was subjected to the same treatment with a view to obtaining benzene and toluene.

2. Two methods of experimentation were used and compared:

(a) Anhydrous aluminium chloride.

(b) Generating aluminium chloride in the body of the oil by the action of hydrogen chloride on aluminium in the presence of a catalyst.

3. A table of comparison is given involving the yields of benzene and toluene from the following methods:

(a) Action of aluminium chloride on pure xylenes.

(b) Action of aluminium chloride on commercial solvent naphtha.

(c) Cracking solvent naphtha under temperature and pressure.

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New York City.

Memorial to Joseph Priestley.—A plan for a suitable memorial to Joseph Priestley has been adopted by a committee of the American Chemical Society, which involves subscriptions to a fund of at least \$2,000 to provide, first, for a bust portrait of Joseph Priestley to be deposited as a loan in the National Museum in Washington; and, second, for the award of a gold medal at intervals for superior achievement in chemical research, the recipient to deliver an address before the general meeting of the society.

¹Moore and Egloff, Met. and Chem. Eng., 13, 682, 1915.

²Egloff and Moore, Jour. Ind. Eng. Chem., 9, 40, 1917.

³Ibid.

Some Applications of Magnetic Analysis to the Study of Steel Products*

By Charles W. Burrows

INTRODUCTION

The possibility of making use of magnetic determinations for estimating the mechanical properties of steel has long been before our minds, a great deal of experimental work has been carried out, and many questions have been answered. The fundamental principle that there is an exact correspondence between magnetic and mechanical properties has been established beyond doubt. Considerable headway has been made in the practical application of this principle. At the present time laboratory tests are being made upon tools, cutlery, springs, ball bearings, cables, rails and a few other articles. Not only are the laboratory methods capable of being expanded into practical shop or commercial tests, but the actual development along certain lines is in progress.

DEFINITION OF MAGNETIC ANALYSIS

The science of magnetic analysis consists of the systematic correlation of the magnetic and other properties of materials and of the application of the laws and principles which underlie the interrelations of such properties, particularly the interrelations of the magnetic and mechanical properties of steel. It is based upon the fundamental fact of observation "that there is one, and only one, set of mechanical characteristics corresponding to a given set of magnetic characteristics, and conversely there is one, and only one, set of magnetic characteristics corresponding to a given set of mechanical characteristics."

The art of magnetic analysis consists in the determination of the magnetic characteristics, or better, a small number of the magnetic characteristics, and from these observations making estimations of the mechanical properties.

CRITERIA OF MECHANICAL PROPERTIES

The nature of a piece of steel may be studied by observing its behavior under the action of certain mechanical forces. The usual mechanical tests result in the destruction of the specimen so that it is not feasible to give such a test to the identical material to be used in a given structure. Even such superficial and intensely localized tests as the Brinell ball hardness test and the scleroscope test require the finishing of the surface tested, and after their application leave the surface in a modified condition.

Another very common way of examining steel is to determine its chemical constituents. The chemical analysis is extremely valuable and is usually considered as being the most valuable criterion of the mechanical possibilities of the steel. This test also must be made on a part of the material which does not enter into the final structure. The assumption must be made that the sample analyzed is substantially of the same composition as material to be used in the construction. The chemical analysis, however, is entirely inadequate to

tell what condition the steel may have been left in as a result of its previous thermal and mechanical treatment.

In order to determine whether the steel has had proper heat treatment for a given purpose it is customary to examine the structure of the steel under the microscope, after the surface to be examined is carefully polished and etched by some suitable means. However, the microscopic analysis becomes difficult in the fine-grained steels. Here the structures of steels of slightly different heat treatment are so nearly alike that it is possible to make only a rough estimation of the heat treatment from the microscopic observations.

The mechanical, chemical and microscopic analyses of steel form the basis for the customary specifications and testing. They are, however, open to one or more of the following objections:

1. The test is vicarious. The actual material which is to be used in practice is not itself tested. Usually a certain percentage of the gross amount of material is set aside for test and the remainder is used in construction. This assumes either that the material is all homogeneous or that if non-uniform the test sample is a true representative of the entire lot. It is only by extreme care that either of these assumptions is even approximately met.

2. The test is destructive. In the tension test the specimen is usually broken. The chemical examination changes the nature of the material so that it no longer has the properties of the original. Hardness tests mar the surface to greater or less degree. This destructive nature of a test renders the piece tested unserviceable, no matter how excellent it might have been before the test.

3. The test is local. Chemical analysis may be made upon a drilling, which constitutes only 1 per cent of the sample submitted for test, which sample itself might be considered as representative of one hundred times its own magnitude. A hardness test involves still less material and even this small amount lies within a short distance of the outer surface of the test specimen. The limit of minuteness, however, is attained by the microscopic sample. The usual micrograph represents an area of less than one millimeter in diameter and is quite superficial.

4. The test may be qualitative. Some of these tests are valuable only when compared with similar tests on other material which may be considered as reference material.

DETERMINING FACTORS IN THE MECHANICAL PROPERTIES OF STEEL

It is well known that two pieces of steel which differ in any one of a number of particulars show correspondingly different mechanical properties. It is well supported by experimental evidence, but not so generally known, that two pieces of steel which differ in certain particulars, likewise show corresponding magnetic differences. It is not feasible to go into great detail on this point at this time.* For the purposes of the present paper it is sufficient to give a few rather well-known examples of this correlation.

The changes that are brought about by adding certain chemical constituents to steel are well known. In

*A paper, with certain omissions, presented at the Atlantic City meeting of the American Society for Testing Materials, June, 1917.

¹Burrows, "Correlation of the Magnetic and Mechanical Properties of Steel," *Bulletin, Bureau of Standards*, Vol. 13, p. 207 (Scientific Paper No. 272).

²In a scientific paper soon to be published in the *Bulletin of the Bureau of Standards* will be given many details on the correlation of the magnetic and mechanical properties of steel. This article will contain a rather comprehensive bibliography.

many cases the corresponding magnetic properties have been studied. With increasing carbon content in a hypo-eutectoid steel there is an increase in hardness and tensile strength and a decrease in toughness. Magnetically an increase in carbon content is accompanied by an increase in coercive force and hysteresis, and a decrease in permeability. Many other cases might be cited.

Mechanical operations also bring about corresponding changes in both the mechanical and the magnetic properties of steel. The cold drawing of a carbon steel increases its tensile strength and simultaneously increases its coercive force and hysteresis. Cold drawing also decreases the magnetic permeability.

The influence of heat treatment upon the properties of steel is fairly well known. A 1 per cent carbon steel quenched in water from a temperature above its critical point has a greater tensile strength than the same material in the annealed condition. Its hardness is also increased while its toughness is greatly decreased. Magnetically, changes of equal magnitude also occur on quenching. The quenched steel has a greater coercive force, a greater hysteresis, and a lower permeability.

In a specific case a 1 per cent carbon steel in the quenched and the annealed conditions had Brinell hardness numerals, in terms of kilograms per 0.1 mm. indentation of 4390 and 800 respectively. The corresponding values of the coercive forces for a magnetizing force of 150 gauss were 33 and 12.

Steel changes with lapse of time. The course of this change is not so well known as some of the above changes. However, both mechanical and magnetic changes occur. Glass-hard steel softens with age. The same steel shows a decrease in coercive force.

The mechanical properties of a bar of steel may differ from point to point if the bar has not received the same treatment throughout. For instance, if a uniform bar is given a slight bend and again straightened it will show a slight change in its mechanical properties. There will be an increase in both hardness and tensile strength. The same bar will show a corresponding decrease in permeability in the same region.

Even during the operation of stressing a bar we feel sure that changes in the mechanical nature are occurring. Less is known about this phase of the problem than the preceding. However, we do know that small alternating stresses, even though well within the elastic limit, leave the material mechanically fatigued and if the stresses are repeated often enough rupture occurs. While it is difficult to study the changes in mechanical properties after repeated or alternating stresses, the magnetic problem is quite simple and has been investigated to some extent.

PRACTICAL APPLICATIONS OF MAGNETIC ANALYSIS

Magnetic analysis may be applied to determine the nature of the steel as a raw material, as a finished product, or even after it has been subjected to service conditions.

RAW MATERIAL

It is obvious that one cannot get a good product from inferior materials. Consequently it is desirable to know the nature of the raw stock that enters into the construction of the finished product.

Raw material must be uniform in quality. The proper mechanical and thermal treatment must be de-

termined for each steel that is used. It very frequently happens that two steels of quite different composition may give equally good performance for a particular service provided each steel is given the appropriate heat treatment. In general the heat treatments required for the two steels will be different. It is desirable, therefore, that all the different bars of a given lot of material shall be of the same quality as the material for which the proper heat treatment was determined. Such assurance requires the examination of every individual bar of steel.

The requirement that all bars shall be alike in properties, implies that each bar shall have the proper composition, shall be properly forged, rolled or drawn, as the case may be, and shall be free from local imperfections such as blowholes, segregation, etc.

Occasionally a lot of steel of the wrong composition is supplied through error; or, by some chance, a single bar of different composition may get mixed up with the general stock. If not detected such a bar may cause much loss or annoyance. Very frequently a steel, especially among the alloy steels, may have the proper chemical composition but with the elements not in the proper state of solution.

Another defect that sometimes is found in cold-drawn material is the tearing apart of some of the crystals beneath the outer surface.

Many of these defects would pass unnoticed in the usual examinations by the chemist, microscopist, or mechanical tester. In such cases as the above a magnetic examination may be expected to be of service.

FINISHED STEEL PRODUCTS

The individual test not only permits the elimination of defective pieces but also permits the grading of a product which, while satisfactory in general, is not all of the same degree of perfection. This process of grading will enable the manufacturer to offer a uniformity of product hitherto unknown and permit him to guarantee such uniformity with surety. It is true that certain tools will have to be sold as seconds at a reduced price. On the other hand there will be a new class of exceptional quality which will bring a correspondingly higher price.

The individual test will permit improvement in design. At present we insist upon factors of safety so large that there would be a reasonable factor of safety even though there were a considerable amount of defective material. For example, a cast-iron structure might have a factor of safety of ten while a similar structure of steel would be safe with a factor of four or five.

Frequently it is desirable to make exhaustive tests upon a few pieces. Such cases arise where one or more samples are submitted in competition with other material. I recently witnessed a test on the results of which an order of \$200,000 was to be based. Five pieces worth about \$2.00 each were submitted by each competitor. The properties of each sample depended upon proper composition and proper heat treatment. Even though the composition were correct a slight error in the heat treatment would place the material at a disadvantage. By a suitable magnetic test the manufacturer could have assured himself that his samples were representative of his best product.

I have made laboratory tests on a number of com-

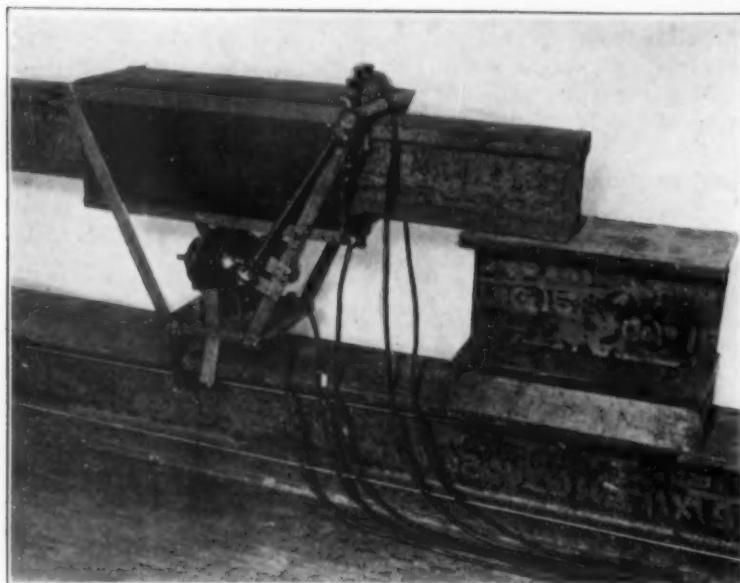


FIG. 1—SOLENOID FOR TESTING MAGNETIC LEAKAGE

mercial articles with considerable success. Experimental evidence already at hand shows that it is feasible to apply individual magnetic tests to many forms of tools, cutlery and springs. These tests are of such a nature that they may be carried out on a commercial scale. Rings and balls for ball bearings are now being tried out by this method with every promise of success. Steel rails, in spite of their size, lend themselves very readily to this method of examination.

SERVICE EFFECTS

Since the magnetic and mechanical properties of steel suffer changes with the lapse of time and under ordinary service conditions, the magnetic method offers a very promising means of examining, without destruction, the changes that develop during the life history of a structure. Some of the things to be looked for are the ordinary results of wear and tear. A good example of this is the mine or elevator cable. Such cables grow old and lose their usefulness or even become a source of danger due to the wearing away of the material, the breaking of strands, excessive strains, the development of a crystalline structure, etc. The causes of deterioration of a cable are so numerous and the possibility of disaster frequently so great that it is customary to replace an old cable by a new one while several years of usefulness remain in the cable. A proper magnetic test would keep the cable under surveillance at all times and make an autographic record.

A structure may fail by the development of flaws. For instance, a steel rail may render apparently satisfactory service for several years and finally develop a transverse fissure which results in a dangerous accident. Periodic examinations of rails which are under suspicion because of excessive duty or other causes may be made and we may thus detect the presence of such a flaw in an early stage of its development.

Another field which has not as yet been tried but for which the possibility has already been established is in the study of the state of stress of a given structural member. For instance, it may be desired to determine whether a given member in a bridge undergoes tension or compression during the passage of a train. The fact

that steel suffers certain changes in its magnetic properties when put under tension and certain other changes when put under compression renders such a determination possible.

ROUTINE TESTS

The apparatus required and the procedure of testing depends to a great extent upon the nature and size of the material tested as well as upon the characteristic flaws to be expected. Apparatus for examining safety-razor blades is necessarily quite different, notably in size, from apparatus for the testing of steel rails. In the case of a lathe tool in which only the nose is hardened the examination differs from that of a locomotive driving rod which is more nearly uniform throughout.

RAILS

If the testing of rails is to give a certainty of the quality of the material, it is necessary to test not only each rail but every element of the length of each rail. This may be accomplished by a double magnetic test. One part of the magnetic test will determine whether there are non-uniformities along the length of the rail. Since this test is based upon a determination of magnetic leakage it is referred to as the "leakage" test. The leakage test determines the homogeneity of the rail. Inhomogeneities, while they may not be due to dangerous imperfections, always cast suspicion upon the rail. Inhomogeneous rails should not be used in places where the highest degree of perfection is required. For instance, inhomogeneous rails should not be used on bridges, in tunnels, or where the traffic is heavy. Homogeneity in itself is not evidence of perfection. A rail may be quite uniform along its length and yet be an unsafe rail. Its dangerous nature may be due to improper chemical composition or to errors in the process of manufacture such as improper finishing temperatures or excessive cooling rates. To determine whether or not such defects exist requires a determination of one or more magnetic constants. These measurements may be made in some form of permeameter and in conformity with the nomenclature for similar tests on small specimens, we call this part of the magnetic examination the "induction" test.

Fig. 1 shows the general appearance of the leakage apparatus for rails. A magnetizing solenoid is moved

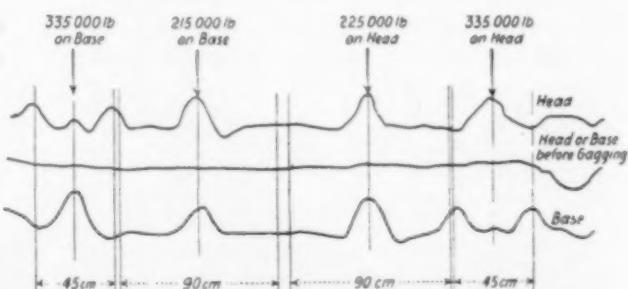


FIG. 2—LEAKAGE CURVES OF A RAIL BEFORE AND AFTER GAGGING

Vertical Arrows Indicate Position of Application of the Gag.
Horizontal Arrows Indicate the Distance Between the Supports.

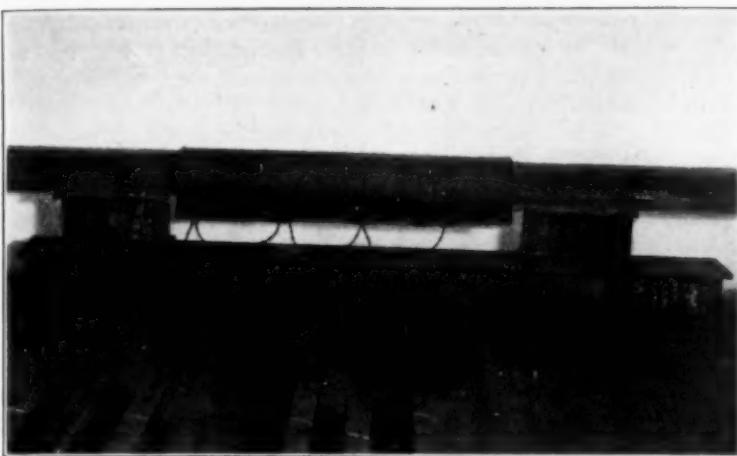


FIG. 3—SOLENOID FOR INDUCTION TEST

along the length of the rail. Any non-uniformity along the rail will cause a variation in magnetic leakage. This variation in leakage develops a small electromotive force which is approximately proportional to the degree and

It is one of a set of rails which was expressly prepared for this investigation. The rails as they left the hot bed were practically straight and therefore did not need to go through the gag press.

The middle record shows the normal record of a rail free from inhomogeneities. The irregularity in the curve at the right-hand end is due to the starting of the apparatus and therefore has no significance. From these curves several observations were made.

1. The rail before gagging shows a magnetic-leakage curve which is substantially a straight line.

2. Pressure applied locally so as to deform the metal produces a magnetic inhomogeneity at the point where the pressure is applied. This is true whether the pressure is applied on the head or on the base.

3. The extent of this local inhomogeneity depends upon the distance between supports. If the supports are far apart the strain seems to extend over the entire cross-section and seems to be greater on the side

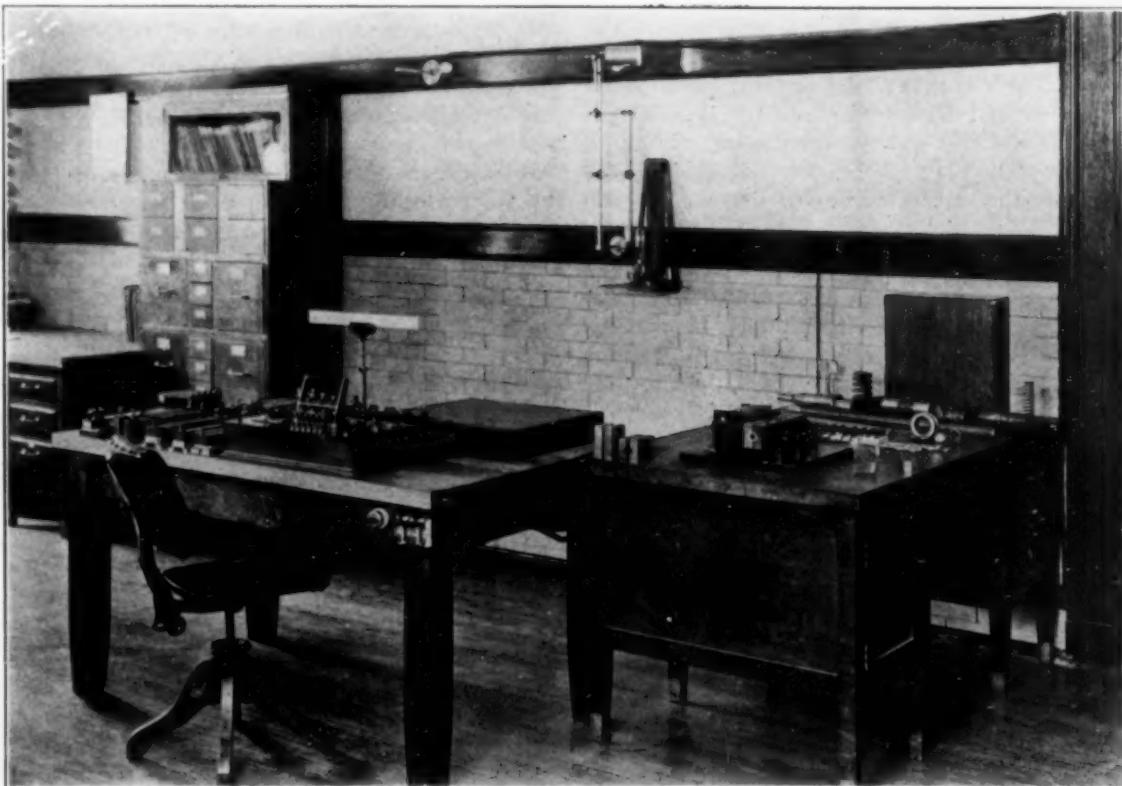


FIG. 4—MAGNETIC TESTING EQUIPMENT FOR SMALL OBJECTS

sharpness of the non-uniformity. A special recording voltmeter, not shown on the photograph, makes a photographic record of the magnetic inhomogeneities. This examination of a rail can be made in about one minute and excessive demands for skill and training are not made upon the operator.

Fig. 2 shows a set of magnetic-leakage records of a 105-lb. rail before and after gagging. This rail has the following chemical composition:

Carbon	0.68%
Manganese	0.98
Phosphorus	0.025
Sulfur	0.031
Silicon	0.144

of the rail opposite the point of application. If the supports are close together the strains are localized on the side on which the pressure is applied.

4. The strains set up by the supports depend upon the distance apart of the supports. If the supports are 90 cm. apart the magnetic effect of the supports is insignificant. If they are only 45 cm. apart this effect is considerable. In fact, the side of the rail on which the supports lie shows a magnetic inhomogeneity at each support which is greater than the corresponding inhomogeneity opposite the gag.

5. Other observations on other rails show that the

degree of magnetic inhomogeneity increases with the load applied by the gag.

6. Furthermore it is worthy of note that another rail from the same ingot which had been annealed showed a much less effect for the same gagging stress.

This ability of the magnetic leakage test to indicate the effect of gagging is of importance in view of the fact that many people consider that excessive gagging produces minute failures in the rail which are in effect potential transverse fissures.

The induction test is fairly simple. Fig. 3 shows the test rail and magnetizing solenoids in position. The accessory apparatus, which is similar to that required in induction measurements of small rods, is not shown. The most useful magnetic quantity is probably the coercive force. For the purpose of illustration we may give the coercive forces of two lots of rails of substantially the same chemical composition, made at the same mill, and differing only in their method of cooling. Four rails rolled in winter were from the first ingot which passed through the mill in starting the round for that particular date. Consequently these rails were the first upon the hot bed which was initially cold. Two other rails of substantially the same chemical composition were selected from a full hot bed and from the middle of a round rolled when the atmospheric temperature was 70 deg. Fahr. The averages of the coercive forces for a magnetizing force of 145 gauss were 10.30 gauss for the winter rails and 8.91 gauss for the summer rails. This difference of 1.39 is probably due in great part to the difference in the rate of cooling of the two sets of rails.

TOOLS

Fig. 4 shows a type of apparatus designed especially for the testing of drills, lathe tools, cutlery, etc. It is so arranged that the portion tested may consist of the major portion of the piece or it may be limited to the end portion.

A number of other pieces of apparatus suitable for magnetic analysis have been described more fully elsewhere.²

The coercive force is probably the most important test in the magnetic method, particularly in analyzing heat-treated specimens. An annealed steel may have a coercive force (the force necessary to neutralize residual magnetism) of 10, but this may be about 30 or 40 after the specimen is quenched. The coercive force will indicate differences in quenching temperatures as close as are measurable by means of the pyrometer. With rails it has not been found feasible as yet to apply the coercive force test, but dependence is placed on variations in permeability.

COMMERCIAL MAGNETIC ANALYSIS

The fundamental fact that there is a definite relation between the magnetic and mechanical properties of steel is so well established that the successful application of magnetic analysis to commercial testing is assured. In any particular case the apparatus must be developed and operators trained. However, the diffi-

culties presented are not excessive. Before shop methods of examination of any given product can be installed, a preliminary investigation must be carried out which involves five steps.

1. Magnetic data of representative material must be determined. Good, bad and indifferent materials must be examined and the data thus obtained correlated so that one may know what magnetic characteristics go with each grade of material.

2. From the mass of data thus obtained the most suitable magnetic criteria must be determined. In some cases any one of several magnetic constants may be equally satisfactory. In other cases only one specific constant may be used. Still others may require the combination of two or more magnetic constants.

3. Suitable apparatus must be designed. After the proper criteria have been determined the next step is to determine what type of apparatus is best suited for the particular material to be tested.

4. Limits of quality must be determined. Since the proper combination of speed, cost and accuracy may call for some slight deviation from the ideal theoretical considerations, the material to be tested must be examined by the final form of apparatus. From these data the final criteria of quality must be determined.

5. The final step of this preliminary investigation is the reduction of all the operations to mere routine, so that shop determinations may be made by an observer who is not necessarily an investigator.

It is not feasible to make an estimate of the cost of the testing equipment. However, it would not be excessive. The rail-testing apparatus shown could be duplicated for about \$1,500.

Explosions of Picric Acid

By T. Sington

The process of making picric acid consists broadly in mixing carbolic acid with strong sulphuric acid, diluting this sulphonate with water and then running it slowly into nitric acid. The mixture is allowed to cool, when the crude picric acid crystallizes out and it is subsequently purified by re-crystallization. After thorough washing with water to remove all traces of free nitric and sulphuric acids, the material is whirled in a centrifuge to remove the bulk of the water. It is then removed to the drying shed where it is spread on glass steam-heated beds until all moisture is removed. The acid is then transferred in large open drums to the sifting room where it is ground, passed through a revolving screen, taken to the packing room, and packed in barrels of 100 pounds each. The large crystals which fail to pass through the sieve are reground in a crushing mill.

A suitable range of buildings for the manufacture of picric acid may consist of five buildings in which the wet processes of manufacture are carried out, and of four or more others in which the acid is dried, sifted, packed, and stored. These buildings ought to be separated from one another and from the "making" rooms by intervals of about 30 feet.

Explosions in picric acid factories are of rare occurrence, but the destruction is then so thorough that there is considerable difficulty in tracing the cause. In opinions based on prolonged experience and on records ex-

²Burrows, "The Determination of the Magnetic Induction in Straight Bars," *Bulletin, Bureau of Standards*, Vol. 6, p. 31 (Scientific Paper No. 117).

Fahy, "A Permeameter for Magnetic-Mechanical Testing," *Electrical World*, Vol. 69, pp. 315-317 (1917).

Burrows and Fahy, "Magnetic Analysis as a Criterion of Steel and Steel Products," *Bulletin, Bureau of Standards* (a forthcoming Scientific Paper).

tending over a long period of time, it has been considered that an explosion is impossible, provided the quantity of acid in any one building is limited to a moderate amount and that the acid is absolutely free from picrates. An entire factory may thus be regarded as constituting a fire risk, rather than an explosion risk, and consequently no distances beyond those necessary to prevent the communication of fire are necessary. Brick walls have therefore been deemed sufficient to protect life, inasmuch as explosions of picric acid have always been preceded by a fire of some minutes' duration.

In the case of an explosion of picric acid two separate and distinct questions may present themselves for discussion: First, the means by which the heat necessary for ignition is produced, and, secondly, why an ignition may develop into an explosion, instead of merely resulting in a comparatively harmless combustion. One of the manufacturing processes through which the material passes is of a nature which in connection with explosives is never entirely free from risk—this is the operation of grinding the larger crystals of picric acid which have failed to pass through the screen. While picric acid is by no means easy to ignite, when it occurs ignition is most likely in the grinding mill. Thus, the operation of grinding *dry* acid occasionally gives rise to fires, which may not be followed by explosions and which are readily put out, but the possibility of explosion is always present.

That the mere process of grinding is not necessarily dangerous follows from the immunity experienced during the operation of drilling out the primer space in the solidified charge of filled shells by means of power-driven steel drills, a method which has been very generally employed without the slightest accident. It does not necessarily follow that because picric acid may be safely ground in an iron mill, that nails, stones and similar hard foreign bodies which may accidentally find their way into the powdered material, are equally harmless. In fact, many fires in picric acid factories have been traced, after careful examination, to the presence of a nail in a grinding machine. Foreign bodies may find their way into the hoppers of grinding machines in a variety of ways, but it is contrary to all experience that an explosion should follow ignition. Should this occur, it would be necessary to reconsider all previous conclusions, and even to modify to a very considerable extent the conditions of manufacture.

A picric acid explosion of exceptional violence, causing widespread destruction of property, occurred in one of the manufacturing towns of Great Britain many years ago. After an exhaustive inquiry it was established beyond all possibility of doubt that the explosion was due not to picric acid alone, but to the presence of considerable quantities of lead and strontium compounds, which under the influence of heat and in contact with the melted picric acid led to the formation of lead and strontium picrates, both of which, and more particularly the lead salt, are not only in themselves violently explosive, but are capable of detonating picric acid in contact with them. Another explosion of picric acid occurred after a fire had been raging for nearly ten minutes; it was said to have been due to the formation of picrate of lime from the mortar in the roof of one of the buildings.

Textbooks for many years stated, on the authority of

chemists of the highest standing, that when suddenly heated, picric acid will explode, but the actual experience of manufacturers furnishes a very emphatic contradiction to this statement, that pure picric acid when unconfined cannot be exploded by fire. Investigation of accidents such as the above also support this view, as do also the results of experiments instituted for the special purpose of clearing up this point. A case is recorded in which an iron vessel with a very small orifice and containing 25 lb. of picric acid was placed in a reverberatory furnace, when the acid burned away without explosion.

It has been found quite possible to explode picric acid by a blow, but the blow must be one of considerable force, if the material is cold. In fact, all experience appears to prove, as surely as negative evidence can be said to prove anything, that it may be taken as a practical impossibility for picric acid to explode without giving sufficient warning by fire to enable anyone in the vicinity to escape, and moreover a fire in its initial stages can be extinguished by water without much difficulty.

In the best planned picric acid factories the quantity of material which may be present in any one compartment is limited to 2000 pounds. When this limit is adhered to, and suitable sprinklers fitted up in every building liable to contain picric acid, the danger of a fire developing into an explosion is so slight as to be negligible. The process of dry grinding is also being discontinued, and some method of dealing with large crystals in a wet state substituted.

Manchester, England.

Control of the Chamber Process of Making Sulphuric Acid

At the winter meeting of the American Institute of Chemical Engineers held in New York, February, 1917, Andrew M. Fairlie of the Tennessee Copper & Chemical Company, presented an abstract of a paper on a method of controlling the chamber process. This was published in our issue of Feb. 1, 1917, p. 149. In the *Chemical Trade Journal and Chemical Engineer* for April 7, 1917, H. E. S. Cory discusses the same problem and says that the Fairlie analytical method, while excellent, does not, perhaps, go far enough. He says the important point, *i.e.*, keeping down the nitre consumption, has engaged the attention during the last few years of many technical managers in England, and has resulted, in some of the more up-to-date works, in the application of much more scientific methods of controlling the chamber process. The well-tried methods (*a*) of observing temperature differences at different points in the system, (*b*) noting the color of the gases, and (*c*) a combination of the two, are still very useful in conjunction with other means, though it must be admitted that in many works to-day these remain the only methods utilized.

To control a plant, and to work it economically on a scientific basis, many observations and tests are necessary, and in the larger and more modern of our works, where able technical control is available, the standard has been greatly improved.

One great point, frequently formerly and indeed often to-day practically ignored, is the necessity for maintaining an adequate supply of atmospheric oxygen in the system, this being regulated in conjunction with a com-

paratively rich burner gas. A series of daily tests of the burner gases for SO_2 , SO_3 , and oxygen are very necessary, and often considerable fluctuations are to be found, particularly in the case of hand-worked burners, the variations being due largely to working operations from time to time. Most particularly on sets working with a low chamber space, the need for a good supply of atmospheric oxygen is very essential, since otherwise the nitre will supply the deficiency, thereby causing loss of efficiency with regard to the full utilization of the nitrous gases, and, incidentally, raising the amount to be added at the nitre ovens.

Granted an adequate supply of inlet oxygen in the burner gas (9 to 10 per cent is a good figure when using pyrites), a rich SO_2 is also to be aimed for, say $6\frac{1}{2}$ to $7\frac{1}{2}$ per cent, and at the same time a sufficiency of oxygen at the exit should be available. With a "tight" set this latter figure should not fall below 5 per cent, and to a large extent will regulate the composition of the burner gas itself.

The percentage of total acids and oxygen in the gases leaving the Glover tower, but before entering the first chamber, is another useful test, as it demonstrates the amount of work done by this tower and is an aid to the most effective working of the Glover. Again, the functions of the Glover tower are to be constantly observed, so that one obtains (1) perfect denitration, (2) effective gas admixture and cooling, (3) satisfactory concentration of acid, (4) efficient cooling of the acid leaving the tower, and (5) free gas passage through the tower.

The temperatures of the gases at the front and back ends of the first chamber should be noted at regular intervals, and water gages placed at various progressive points in the system serve to show the speed of the gases.

"Drips" placed at frequent intervals on all the chambers indicate the strengths of acid being made, and should be compared with the strengths of the "bottom acids" in the chambers, which comparison varies accordingly as water sprays, steam, or a combination of both be used, and depends somewhat upon the position and shape of the "drips" or drip-catchers. The "bottom acids" should be tested frequently for strength and nitrosity, and the drips occasionally and qualitatively for nitrosity.

It is highly desirable that the acid in the chambers be thoroughly circulated, so that all acid is drawn off at the front end of the leading chamber after traversing the length of all the chambers in the system and always moving in the opposite direction to the gases. By using connecting chutes alternately at opposite ends of the various chambers such a circulation can be easily carried out, and intimate contact between acid and gases is established, fresh acid surfaces continually presenting themselves. Also, the leading chamber may be used as a "denitrating" chamber, so that all acid run on from the chambers is free from nitrous compounds. This is not essential, and often not advisable where the whole or a large part of the acid make is concentrated by the Glover tower.

Any nitre contained in the "bottom acid" flowing round through this leading chamber is thus evolved, and, intermingling with fresh gases from the Glover tower, proceeds through the system again.

At times acid may be again dispatched to the last chamber after having worked round, in order to come

forward again, thus maintaining an active acid circulation continually. With acid continually on the move, a nitre content to a reasonable extent frequently helps the workings, and at the same time does not damage the lead materially, as no stagnant acid is present in the system.

The acid distribution on the tower tops requires regular attention, and constant flows, particularly on the Glover tower, should be maintained. Any shortage or excess of nitrous vitriol in the circulating acids can be remedied by adjustment of the absorber tower feeds, the Glover feed never being reduced for this purpose.

As oxygen is required in the absorber towers to insure correct chemical reactions, gas tests taken between the last chamber and first absorber are most useful. The SO_2 at this point should not exceed 0.1 to 0.2 per cent, and oxygen should be 5 per cent or more, these figures applying to sets burning pyrites. However, a rise in these figures does not necessarily demonstrate a deficiency of nitre in the system, but may be due to excessive draught, which is easily righted.

Tests of the gases for total acids, *i.e.*, SO_2 and SO_3 , combined, together with oxygen, may be taken occasionally at the end of each chamber, and give the operator an indication of the comparative work done by each chamber in the set.

On the absorber towers cool acid is essential, and should not exceed 90 to 100 deg. Fahr., while a minimum strength of 140 deg. Tw. is desirable. Where two absorbers or a series are working, intelligent variation and adjustment of the flows render absorption the more satisfactory.

In a well-regulated system one important aim is that of maintaining a good "nitre circulation," and to this end the acid flowing down the Glover should be frequently measured at the inlet, the nitre contents being tested simultaneously. This enables the circulation of nitre going forward from the Glover tower to be calculated in pounds of NaNO_3 per hour or similar convenient form. An efficient and constant nitre circulation obviously is to be aimed for, as the nitre added at the pots is thereby reduced.

Nitrosity tests of the acids leaving absorber towers should be taken thrice or more daily, and the gas "smell" test is very useful. The mode of operating the latter is as follows: The operator takes a sample of chamber gas into a small hand aspirator consisting of a rubber bulb fitted with a glass tube jet at a place not too far back in the system. A little experience enables the operator to judge how his chambers are working by differences in the "smell" of the gases, and any variation or tendency toward "souring" is checked in good time by an extra charge of nitre at the pots.

Exit tests may be done with advantage about thrice daily (express as grains SO_3 per cubic foot of gas), and a good working figure should usually not exceed 1.8 to 2 grains. As the "burner gases" at certain periods come forward into the chambers in "flushes," the following method of applying the nitre at the pots is recommended as being most economical. A minimum amount of nitre is added each hour at the pots, and this should be accurately weighed on a scale, and at intervals this amount is raised—*i.e.*, if 10 lb. per hour is being potted, perhaps every three or four hours, 20 lb. would be added in order to counteract the gas "flushes." This is undoubtedly more economical than using a regular and heavier

charge of nitre hourly, and the "smell" test is of great utility at this point. With the latter method a continuous nitre saturation is present, and this state of affairs is certainly not beneficial to the leadwork, as, on the contrary, occasional "souring" of the gases has, if anything, a good effect upon the leadwork.

A fan worked by direct-coupled motor and equipped with variable speeds should be fitted between the two absorbers, and the speed taken at regular intervals. A convenient speed for most systems is 300 to 400 r.p.m. on the fan.

A control damper fitted in the draft pipe between the last chamber and the first absorber is very suitable, and the sizes of the draft pipes should gradually diminish throughout the system. Inspection doors fitted into the chamber curtains at a height of some 3 ft. or 3 ft. 6 in. above floor level enable the operator to observe the color and movements of the gases, and are useful when acid samples are required. These doors should preferably be at an angle of 45 deg. to the lead curtain. The speed or draft is an important factor requiring frequent observation.

The control of the burners or furnaces is the most important part of the system; the control of the burners largely depends upon the analysis of the "burner gases," but painstaking examinations of the burners themselves are necessary to insure good and regular chamber workings.

By adopting such means of control as described, he states that a most economical nitre usage with a maximum make of acid should be obtainable. A maximum figure for "nitre circulation" should be decided upon for each set, as too much nitre going forward, while reducing the amount to be added at the pots (to make good chemical and mechanical losses), has a detrimental effect upon the chamber leadwork. With a reduced chamber space, however, the nitre circulation requires usually to be raised, and this undoubtedly largely contributes to the increased wear and tear. Where several sets are working together or adjacently, as in many of the larger and more modern works, these methods of control should prove very useful. Where nitric acid is used the same rules apply, though nitre may also be used for the purpose of counteracting gas "flushes" where practicable.

Synopsis of Recent Metallurgical and Chemical Literature

Japanese Industries

Current Chemical News from Japan.—In Vol. 1, No. 4, of the *Chemical Technology* are given several pages in English of current news from Japan, as in previous numbers. In regard to the iron and steel industry it says the production in 1914 was 303,407 tons and the consumption 1,300,000 tons. Recently a great many new companies have started up and old ones have so expanded that the production has increased enormously. The available ore is given as 50,000,000 tons of magnetite, 4,293,000 tons of hematite, 494,000 tons of brown iron ore, and 226,000 tons of sand iron. This will not last long and Japan is investigating in Manchuria, Korea and inner China for further supplies.

Gelatin and Glue.—In regard to gelatin and glue the following is of great interest:

"The importation of gelatin and glue had increased its amount to a million yen, and the quick development of our paper, spinning, cloth-finishing, sweets-making and match industry has demanded more and more importation. But the manufacturing of the gelatin and glue at home has also quickly developed. The research work has been also established at Tokyo, Osaka, Wakayama, Nara and Tokushima.

"Among the new establishments, the Takasago, Kogyo Kabushiki Kwaisha is the largest, which is going to produce 10,000 lb. gelatin and 15,000 lb. glue monthly. Furthermore, the Osaka-Alkali Company is going to start the manufacturing, while the Mitsubishi Company is enterprising a big firm at Kakogawa. These big firms will certainly bring a big surplus against our home trade and we must expect certain panic in a near future unless they will find a proper market."

Chemical Exhibition.—An exhibition of chemical products is being arranged and it is hoped to open same in October.

Wood Distillation.—Prof. Dr. Tamara has issued a report as follows:

Total demand of 80 per cent Ca-acetate per month is:	
For glacial acetic acid.....	110,295 kwan.
For acetone	61,250 "

Total	171,545 "

Total production of 80 per cent Ca-acetate at home is:
The Nippon Acetic Acid Co., Shiobara

Works	13,800 kwan.
Kabafuto (Sagalin) Government Works.	8,280 "
Tottori-ken, Kondo Works.....	3,600 "
Chichibu Distillation Works.....	3,200 "
Wakayama Province.....	20,000 "
Saetama Province	5,000 "
Others	7,000 "

Total	60,880 "

This output is only 36 per cent of the demand, the rest, 64 per cent, being imported. On the other hand, the demand of glacial acetic acid at rubber districts of Oceania has lately enormously increased.

Crude methyl alcohol is also much required, which is converted into 99 per cent pure methyl alcohol, 95 per cent spirit, 90 per cent spirit. Among them, the pure methyl alcohol is much consumed for the manufacturing of formalin. The total demand of formalin at home is about 1,500,000 lb. annually, which corresponds to about 1,250,000 lb. 99 per cent methyl alcohol, or 3,125,000 lb. crude methyl alcohol. That is, we require about 260,000 lb. crude alcohol per month. At present crude alcohol is produced monthly as the following:

The Nippon Acetic Acid Co., Shiobara	
Works	18,000 lb.
Kabafuto Government Works.....	15,000 "
Tottori-ken, Kondo Works.....	3,600 "
Chichibu Works.....	1,000 "

Total	37,600 lb.

This amount is only 14.5 per cent of the total demand. We want further wood tar, not only for the producing of formalin, but for the manufacturing of creosote, guiacol, guiacole carbonate, thiocole.

Refractories

Hot and Cold Sizes of Firebricks.—In the *Iron and Coal Trades Review*, June 15, 1917, the results are given of experiments by J. W. MELLOR, on hot and cold sizes of typical firebricks. The article is included in a report of the Refractory Materials Committee of the Institution of Gas Engineers, made at its meeting in London June 5. The experiments were carried out at the County Pottery Laboratory, Stoke-on-Trent, and formed one of a series on refractories.

The measurements on the whole brick were made with Coppée's apparatus. Two cuts are made in the brick; each cut is intended to hold a pointed platinum wire. The two saw cuts are arranged so that the wires fit tightly. The distance apart of the tips of the wires is measured while the brick is cold (15 deg. C.) by means of a cathetometer provided with an invar scale. The brick is heated in a furnace to the desired temperature, and, by means of suitable apertures in the furnace, the distance apart of the wires is measured again. The results are indicated in Table I.

TABLE I

Type of Brick	Distance Between Platinum Wires. Before Firing. Cms.	Distance Between Platinum Wires. After Firing. Cms.	Percent- age Ex- pansion	Linear Co- efficient of Thermal Expansion
Silica brick	17.95	18.05	0.56	0.0000048
Firebrick	18.78	18.87 (5)	0.51	0.0000044
Firebrick	20.31	20.45	0.69	0.0000059
Firebrick	19.43	19.50	0.36	0.0000031
Firebrick	20.06	20.25	0.95	0.0000082
Silica brick	20.29	20.43	0.69	0.0000059
Firebrick	19.83	19.94	0.55	0.0000047
Firebrick	19.80	19.92	0.61	0.0000052
Firebrick	19.01	19.06	0.26	0.0000022
Firebrick	18.35	18.42	0.38	0.0000033
Firebrick	18.68	18.80	0.64	0.0000055
Firebrick	18.54 (5)	18.66	0.62	0.0000053
Firebrick	18.77	18.83	0.32	0.0000028
Firebrick	18.29	18.41	0.66	0.0000057
Firebrick	18.71	18.84	0.70	0.0000060
Firebrick	19.41	19.53	0.62	0.0000053
Red silica brick	19.29	19.46	0.88	0.0000076
Silica brick	18.27	18.41	1.77	0.0000066
Silica brick	18.52	18.78	1.40	0.0000121
Silica brick	18.85	18.94	0.48	0.0000041
Firebrick	18.53	18.66	0.70	0.0000060
Firebrick	18.84	18.98	0.74	0.0000064
Firebrick	18.89	19.06	0.90	0.0000177
Firebrick	19.50	19.70	1.03	0.0000088
Firebrick	18.93	19.07	0.74	0.0000064
Magnesite brick	18.39	18.66	1.47	0.0000126

If the brick is imperfectly burned, there is superposed on the effects of thermal expansion an after-contraction or after-expansion. In consequence, in the former case the results are too small, and in the latter case too large. Still further:

(1) The brick does not contract to its original volume on cooling. The difference between the cold sizes of the brick before and after firing shows the magnitude of the after-contraction or after-expansion, when the brick was heated under conditions of the experiment.

(2) In all cases of after-contraction (or, *mutatis mutandis*, after expansion), the brick may show a smaller volume at, say, 1,180 deg. C. than it does at, say, 1,060 deg. C. This shows that the effects of thermal expansion are altogether masked by the after-contraction. Thus:

Distance of wires at	15° C.	18.72 cm.
" "	1,060° C.	18.80 cm.
" "	1,180° C.	18.75 cm.

It was only when the whole of the cold and hot measurements were under consideration and were being extended to different temperatures that the dual character of the phenomenon was discovered; and it has made the Committee suspect these and other measurements

of the coefficients of thermal expansion of refractory materials at high temperatures—unless it can be demonstrated that the results are not affected by the error under consideration.

These measurements also show that the coefficient of expansion of fireclays and of silica bricks decreases with rise of temperature. Thus, in two cases:

Silica Firebricks.

	I.	II.
From 15° to 940° C.	0.0000069	0.0000081
From 15° to 1,180° C.	0.0000060	0.0000060
		Silica Firebricks.
From 15° to 940° C.	0.0000051
From 15° to 1,180° C.	0.0000064

It will be observed that the coefficient of thermal expansion represents the average increase in length which a break undergoes when unit length is heated 1 deg. C.; so that a 9-in. brick with a coefficient of 0.000005 will be 9 ($1 + 0.000005 \times 1,200$), or 9.054 in. long at 1200 deg. C. Otherwise expressed, a brick $2\frac{1}{2}$ in. thick when cold will be $2\frac{1}{2}$ ($1 + 0.000005 \times 1,200$), or 2.515 in. thick at 1,200 deg.; or, neglecting the jointing cement, sixty-six bricks piled one on top of the other would expand 1 in. when heated to 1,200 deg.

After-Contraction or After-Expansion of Firebricks in Oxidizing and Reducing Atmospheres.—Another investigation by the same author dealt with the above subject. It is well known that ferrous iron has a far greater fluxing action than ferric iron, so that the contraction of a brick fired under reducing conditions will probably be greater than when fired under oxidizing conditions, providing no bloating occurs. Nearly all firebricks are burned under oxidizing conditions. It therefore appeared of interest to find the difference in the results obtained in the specification contraction test when conducted under oxidizing and under reducing conditions. Some measurements are given in Table II.

C signifies contraction, E expansion; the specimens marked with an asterisk were fired at cone "12" for two hours, and the others at cone "14." See standard specification.

These results show a general tendency for silica bricks to give a less expansion in a reducing atmosphere than in an oxidizing atmosphere; and for (fireclay) firebricks to give a greater contraction in a reducing than in an oxidizing atmosphere. This result might have been anticipated, because it is in agreement with the much greater fluxing effect of iron in a reducing than in an oxidizing atmosphere.

TABLE II

Type of Brick	Percentage After Expansion or Contraction (Means of Duplicates).	
	Oxidizing Atmosphere	Reducing Atmosphere
Silica brick, unusually fine grained..	0.44	C 0.77 C
Silica brick, high in "iron".....	0.58	E 0.48 E
Firebrick	0.21	E Nil
Firebrick	Nil	— 0.33 C
Firebrick	1.12	C 1.27 C
Silica brick	0.20	E 0.13 E
Silica brick	0.13	E 0.12 E

The magnitude of the fluxing effect induced by the reducing atmosphere depends upon a number of factors. For example: (1) It depends upon the strength of the reducing atmosphere; that is, on the proportion (and kind) of reducing gases in the given atmosphere; (2) it will also depend upon the rate the gases penetrate into the interior of the brick, and this in turn depends upon the character of the superficial skin and on the

porosity of the brick; and (3) on the time and temperature the brick is bathed in the reducing atmosphere. It is, therefore, difficult to get comparable results with the contraction test under reducing conditions. This agrees with some previous results obtained by determining refractory tests under reducing and oxidizing conditions.

For similar reasons, a neutral (or slightly oxidizing) atmosphere was prescribed for the refractory test, until further experiments showed how this source of variation could be eliminated. It would be unwise to prescribe a test which gives variable results. The author expects that further experiments on this subject will be ready for the next annual report; meanwhile, it is recommended that the "contraction test" be conducted like the refractory test—that is, in as nearly a neutral atmosphere as practicable.

Recent Metallurgical and Chemical Patents

Sintering

Apparatus for Roasting and Sintering Ores.—ARTHUR S. DWIGHT of New York, N. Y., has patented

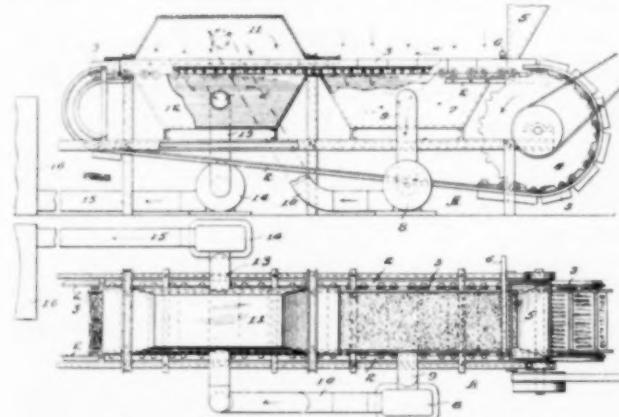


FIG. 1—DWIGHT SINTERING MACHINE

a new sintering machine which is illustrated in Fig. 1. The improvement in this machine over the Dwight-Lloyd machine consists in eliminating the waste of the fine sulphur which is found in gases coming off from some sulphide ores during the operation of the last-named machine. This sulphur is in a very finely divided state and ignites on the gases issuing into the air. It is the aim in this machine to convert the elemental sulphur escaping from such ores into sulphur dioxide, thus increasing the amount of this gas in the gases coming from the machine. This is accomplished by constructing the apparatus in such a way that the ignited sulphide ores may be repeatedly treated by the same volume of air in separate units, i. e., the air used to treat the first unit of ignited ore is passed to a second body of ore and supplying thus the oxygen required for the roasting or sintering of said second body of material. In this manner the patentee has been able to increase the sulphur dioxide content of the gases to 9 per cent, and it is his belief that the proportion of dioxide of sulphur may be increased still more. (1,215,637, Feb. 13, 1917.)

Agglomerating Flue-Dust and Fine Ores.—A patent was granted to WILHELM SCHUMACHER of Berlin, Germany, for a new method of roasting or sintering finely divided ores and flue-dust. The principle employed

consists in incorporating in the form of small, permanent, ball-like or egg-shaped briquettes the finely divided particles of such fine ores whose sintering and melting points are relatively close together, then exposing such briquettes to a temperature between the sintering and melting temperatures of the ores and maintaining continual movement of the briquettes while in the sintering or roasting zone. (1,222,893, April 17, 1917.)

Nickel

Treatment of Nickel Ores.—A patent was granted to FREDERIC A. EUSTIS of Milton, Mass., for the extraction of nickel from its ores by a wet method. The ore is first subjected to heat treatment, preferably a sulphatizing roast. This is done with the intention of converting the nickel into a soluble form. If not enough sulphur is present in the ore as such, 5 to 10 per cent of its weight of sulphur-bearing material such as pyrite should be added. Roasting takes place at about 460 deg. C. and is continued for approximately 4 hours. It is also possible to moisten the ore with the least possible amount of sulphuric acid and then roast at 500 deg. C. for a considerable length of time. The roasting converts a large proportion of the nickel present into the soluble sulphate. A considerable amount of alumina is also converted into the sulphate, while a relatively small amount of the iron is converted into sulphate. The heat treatment also affects the amount of iron which will be taken into solution. Little soluble iron is formed. The roasted product is then leached with dilute sulphuric acid, or with a solvent consisting of water containing one-half of 1 per cent of sulphuric acid and 7 per cent of hydrochloric acid. The solvent should be applied hot (100 deg. C.), so as to prevent as much as possible the solution of iron salts.

The solution containing the nickel and some alumina and iron, is then preferably passed through a trommel containing pieces of limestone. The trommel is slowly rotated and the solution becomes neutralized and calcium sulphate is precipitated. After neutralization has been accomplished the solution should be drawn off and received in another receptacle containing limestone. This will primarily precipitate the alumina and near the end iron will come out. When this point is reached, the solution is again drawn off and conducted into a vessel containing soda ash or some other material forming soluble sulphate. The precipitated nickel may be sold as such or re-treated with a suitable solvent such as sulphuric acid or a solution of ammonium or potassium sulphate in sulphuric acid to form an electrolyte from which the nickel as such may then be deposited. (1,212,334, Jan. 1, 1917.)

Rare Metals

Method for Treating Vanadium-Bearing Ores.—ROYAL S. DAVIS of Newmire, Col., was granted a patent for an improved method of treating vanadium-bearing ores and particularly for the recovery of values ordinarily rejected when treating the ore preparatory to reduction. The ores are subjected to a chloridizing roast in a reverberatory furnace to convert the vanadium into a vanadate. The roasted ore is then leached and the residue left, containing recov-

erable amounts of vanadium in the form of V_2O_5 , is then treated for the recovery of the vanadium content.

The gases coming from the chloridizing furnace are scrubbed and cooled by passing them in a coke tower. The water trickling over the coke collects and absorbs the SO_2 and Cl in the gases. This solution then is applied to the ore residue and it is found will convert the V_2O_5 to a soluble vanadate, which in turn is then leached. It is claimed that the unscrubbed gases may be applied directly to the moist ore, giving satisfactory recoveries. Ten to fifteen per cent greater recovery is claimed for this method over the ordinary water leaching process. (1,223,567, April 24, 1917.)

Alloys

Aluminium Alloy and in Articles Made Therefrom.—A patent under the above heading was granted to ALBERT W. MORRIS of Springfield, Mass. The invention relates to an aluminium alloy and to castings and forgings made therefrom, the object being to provide an alloy which will permit of the full chilling effect of the mold or die, will reduce the shrinkage of the castings or forgings, overcome the danger of cracking, increase the tensile strength and the elongation properties. The alloy may consist of aluminium and iron alone, or it may contain zinc, copper, nickel, cadmium, magnesium and manganese, besides the aluminium and iron. A certain proportion of iron, properly alloyed with the aluminium will, according to the inventor, produce the claimed effects. Where the alloy contains other metals, the percentage of aluminium should not be less than 70 per cent of the whole, and the percentage of the iron present should not be less than from 1 to 6 per cent. Care should be exercised to keep the silicon content as low as possible. The iron may be introduced in the form of ferro-aluminium, ferro-zinc, ferro-copper or the like, or it may be introduced in the metallic state in form of filings or chips, or it may be derived from the furnace pot or crucible in which the aluminium is melted. The invention, it is claimed, is of especial importance in the manufacture of fuses and detonators for explosive shells as it creates a great density in the product and prevents leakage through it of the gases, which would cause premature explosion of the shell. (1,227,174, May 22, 1917.)

Gases

Electrical Treatment of Hydrocarbon Gases.—A process of treating gases, such as illuminating gas with a high-tension electric discharge, is patented by J. G. DAVIDSON and R. W. FORD of Vancouver, B. C. By subjecting a gas or vapor containing a hydrocarbon or hydrocarbons, such as illuminating gas, or other gas produced by the destructive distillation of coal or petroleum, or other methods of manufacture or production, to the action of a high-tension electric discharge under certain conditions, a considerable change may be effected in the final product, indicating an increase in the proportion of fixed gases in the total final product and an increase in the volume of gas produced. An important object of the invention is to increase the percentage of fixed hydrocarbons in illuminating or similar gases, by breaking up condensable constituents into substances of less molecular weight and less condensability. Another object incidental to the above is

to increase the volume of gas produced. (1,229,042, June 5, 1917.)

Platinum Substitute

Platinum Substitute.—Alloys of palladium, silver and cobalt are patented by HUGH S. COOPER of Cleveland, Ohio, and assigned to the Electro-Metals Products Co. of Cleveland, Ohio. One composition stated to be a successful platinum substitute for electrical purposes consists of 70 per cent silver, 25 per cent palladium, and 5 per cent cobalt. Platinum may be substituted for the palladium with good results, and nickel for the cobalt. The alloys are adapted for use in coils, magnetics and all vibrating instruments. (1,229,037, June 5, 1917.)

Iron and Steel

Low-Carbon Ferromanganese.—A method of making ferromanganese containing less than 1 per cent of carbon is patented by ERNEST HUMBERT of Niagara Falls, N. Y. The reduction of the carbon is affected by treating commercial ferromanganese containing up to 6 per cent of carbon with manganese oxide. An electric furnace of the Heroult type is used. A specific example of the process is given as follows: "Take 2000 lb. of ferromanganese containing 6 per cent carbon. This is 120 lb. of carbon, and requires 160 lb. of oxygen. This amount of oxygen will be found in 710 lb. of manganese oxide (MnO). If the reaction were perfect there would result $2000 - 120 + 550$, a total of 2430 lb. of ferromanganese containing no carbon. These calculations are for pure oxide of manganese. As commercial manganese ore is never pure MnO , the calculations must be made on the MnO content. Also a certain excess of the oxide must be used, about 10 to 20 per cent over the theoretical amount, because a certain amount of the oxide remains in the slag. The ferromanganese is introduced into the furnace either cold or molten. If cold, it is first melted in the electric furnace. The manganese oxide is then added. Probably the best voltage to use is 50 volts at each arc, but it may be varied according to the design of the furnace and other considerations. The quantity of current, amperes, should be sufficient to keep the mass at the temperatures stated. A test of the metal will show a reduction of carbon by the appearance of the fracture, being less crystalline and more like steel than in high-carbon ferromanganese. Also the specimen will be less brittle the lower the carbon."

The low-carbon ferromanganese produced by this method is stated to be of a special utility in the making of what is commercially known as manganese steel containing a comparatively high percentage of manganese, ordinarily from 10 to 15 per cent. (1,228,925, June 5, 1917.)

Welding Scrap Nickel Anodes

The practice of utilizing every pound of nickel anodes for service by welding the scraps together is effecting a considerable saving in many plating departments and establishments, and is of special importance at the present time. An account of experiments made by the Prest-O-Lite Co. of Indianapolis, Ind., was given in our issue of July, 1915, page 453.

Until recent years, many firms sold their anodes as scrap for want of a thoroughly satisfactory method

of utilizing them. This was always a source of considerable loss to platers, for the scraps often represent a considerable portion of the original anodes and their junk value is less than one-half their original cost. By welding the scraps together, by the oxy-acetylene welding process, every pound of the costly metal is utilized for plating purposes.

The practice of welding scrap anodes is usually as follows: The worn anodes, as they are withdrawn from the tanks, are turned over to some workman who handles the welding. A scrap of suitable size and shape is selected as a "hanger" and other scraps are "tacked" to it by welding until the desired size and weight are secured. The "tacking" consists of melting the scraps, at the point of welding, by the heat of the oxy-acetylene flame, allowing them to run together or "fuse" into one piece. The "tacking" of a joint requires but a moment as the temperature of the oxy-acetylene flame, which is approximately 6300 deg. Fahr., causes the metal to "fuse" quickly.

No flux is used—the metal simply runs together and where necessary another piece of scrap nickel is used as a filling rod.

The oxy-acetylene flame is also used to remove the brass hooks from the scraps, the solder melting rapidly, leaving the pure anode to be welded.

Several other methods of utilizing scrap anodes have been tried in the past, but with uncertain results. The method of fastening them together by means of rivets and similar methods are seldom thoroughly dependable because of uncertain conductivity. It is impracticable for anyone but the manufacturer to remelt and repour anodes, because in so doing the composition is changed. An advantage claimed for welding the scraps together is that the original composition is

not changed and the fused joints insure conductivity equal to that of new anodes.

Another advantage claimed is the fact that no skill or experience in the art of welding is required to weld up scrap nickel anodes. Any workman of average intelligence can do the work without previous knowledge of the process.

The accompanying illustration shows the welding of scrap anodes by the Prest-O-Lite process of oxy-acetylene welding. Welded anodes are seen in the foreground.

American Sulphur Company Rapidly Expanding

The accompanying illustrations, Figs. 1, 2 and 3, show the pumps, foundations and buildings of the Freeport Sulphur Mines located at Brazoria County, Texas, at the mouth of the Brazos River on the Gulf of Mexico, and are the property of the Freeport Sulphur Company. The discovery of the sulphur deposit was accidentally made while prospecting for oil, and its location is believed to be unique as being the only mines situated at tide water and having a deep-water harbor immediately adjacent from which shipments by vessel are made.

It may be stated that the great sulphur deposit underlies "Bryan Heights," one of the domes which dot the coastal plain. It has an area of about 500 acres, and its crest is but 28 ft. above mean low tide. The sulphur-bearing horizon lies many hundred feet under the surface, surmounted by a limestone cap, the sulphur occurring in pockets and veins in a porous gypsum formation heavily loaded with water, as it is below sea-level. To recover the sulphur, millions of gallons of boiling water are forced into the formation under heavy pressure, searching out the sulphur and freeing it from the rock which contains it. In its melted state it is pumped by compressed air to the surface, where it is forced through piping to immense storage bins, where it congeals and builds up huge blocks of solid sulphur 99½ per cent pure.

It is of interest to note that the largest oil-burning steam boiler plant in this country has been established at the mines to recover the sulphur. The experimental plant, known as plant No. 1, was built in 1912, and has a capacity of 3000 boiler-horsepower. Plant No. 2 was built adjoining plant No. 1 in 1914, and has a capacity of 4000 boiler-horsepower. Plant No. 3, finished this year, and plant No. 4, now under construction, are situated on the other side of the mound and have a capacity of 8400 horsepower each, making



OPERATOR WELDING SCRAP NICKEL ANODES

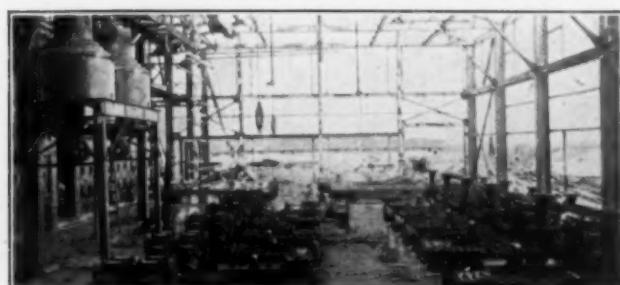


FIG. 1—FREEPORT SULPHUR COMPANY, FREEPORT, TEX.
PUMPS IN PLANT NO. 3



FIG. 2—FREEPORT SULPHUR COMPANY, FREEPORT, TEX.
PLANT NO. 1 AT LEFT, NO. 2 AT RIGHT

a total installation of 23,800 horsepower. The buildings are constructed of steel and corrugated iron on concrete foundations. Fuel oil for boiler purposes requires continual tank steamer service from the Mexican oil fields, and the Freeport Sulphur interests own and operate their own tank line.

It may be mentioned that the boiler water supply is obtained from a series of wells, pumped by air compressors, and is stored in two reservoirs. The mine water supply is obtained from the river through a canal $3\frac{1}{2}$ miles long, and is pumped into two separate reservoirs. Both mine and boiler water are treated with calcium hydrate to remove scale-producing salts before going to the reservoirs, where the precipitation takes place. The precipitated sludge is periodically pumped out of the reservoirs by a hydraulic suction dredge. A day's water supply is pumped and treated in 8 hours, and 7000 lb. of calcium hydrate are daily used in the process.

Electric power is used to great extent, the pumps being electrically driven. The power equipment consists of two 250-kw., 2200-volt generators, and one 500-kva., 22-volt generator. This power plant transmits current to the town of Freeport for lighting and power as well as to the pumping stations. A 4-ton ice-making plant and water-purification plant furnish the works with all ice and drinking water required. All excess steam about the plant is used for heating water. After scale-producing salts have been removed from



FIG. 3—FREEPORT SULPHUR COMPANY, FREEPORT, TEX.
PLANT NO. 3 IN BACKGROUND, FOUNDATIONS
FOR PLANT NO. 4 IN FOREGROUND

the boiler water there still remain salts which cannot be removed by chemical treatment and cause foaming and priming in the boilers.

It is claimed that the concentration in the boilers is kept within safe limits by continuously blowing them off, and special arrangements are made for recovering the heat from the blow-off water. At the water's edge a large timber-loading dock was built. Sulphur dynamited at the storage bins is loaded by means of two locomotive cranes with clamshell buckets into 50-ton cars and carried to the dock.

The storage tracks for full and empty cars at the dock are so graded that cars are delivered by gravity to the foot of the incline leading to the elevated dock structure and empties returning from the dock are delivered by gravity to the empty storage tracks, thus doing away with the service of a switching engine. The loaded cars are hauled one at a time by a barney car operated by a 200-hp. winding engine up the 15 per cent incline to the top of the elevated dock where they discharge the sulphur into chutes leading directly to the hold of the vessel. The empties are returned three or four at a time down the incline by the same means. A 3000-ton ship can be loaded between tides.

Operation of a Temperature Regulator

The enormous pressure developed when oil is heated in a filled metal cylinder is utilized in the Sarco temperature regulator, made by The Sarco Company, Inc., of New York City. The regulator operates gas, steam or water valves and can be used for tank or atmospheric control. Referring to the illustration, Fig. 1, the oil cylinder communicates through a pipe with another cylinder in which there is a piston, the entire system being completely oil filled. The piston in the piston cylinder actuates a valve. If the oil cylinder is immersed in a tank containing the fluid, temperature of which is to be regulated and that tank is heated, say by a gas flame, the supply of gas to which is regulated by the supply valve, the mode of operation is obvious. When the temperature of the tank liquid rises, heating the oil in the oil cylinder, the expanding oil pushes the piston outward in its cylinder and closes down the supply valve, thus reducing the gas flame. If on the other hand the tank temperature falls, the oil in the cylinder cools and contracts, thus allowing the piston in the piston cylinder to go back under the influence of a spring (not shown) opening the supply valve and thus turning the gas flame higher.

Were the piston in the piston cylinder of the conventional type, trouble would ensue because, obviously, successful operation requires that the oil system be absolutely tight, the escape of even a minute quantity of oil altering the whole setting. In other words, it is imperative that the piston packing be leak-proof, capable of withstanding the enormous pres-

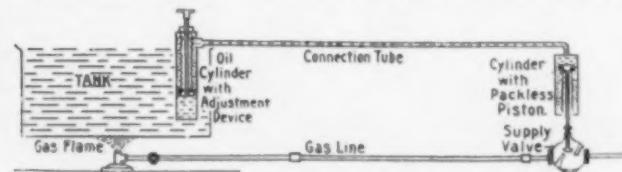


FIG. 1—DIAGRAM OF REGULATOR AND CONNECTIONS

sures which are involved, and at the same time frictionless. The Sarco Company has developed a spirally corrugated tube, a section of the same being hermetically attached to the outer surface of the piston at one end, and to the inner skirt of the oil cylinder at the other end, as shown. This tube will withstand pressures in excess of 3000 lb. per square inch.

While the regulating system as so far described is complete and would be commercially operative, it is naturally desirable to add some means of adjusting the temperature setting. This is accomplished by having the connection tube issue from the side of the oil cylinder instead of from the top, and then inserting from above a piston which can be adjusted up or down by a regulating screw. When adjusted downward the temperature in the tank need evidently rise less before pressure is transmitted through the connection tube to close the supply valve, and if adjusted upward the temperature must rise higher before closing will take place.

A relief element is also supplied which will yield if the pressure after the control valve has been closed should for some special reason continue to rise and exceed even the high limit of strength of the tubing. The element is a special heavy spring interposed between the manually adjustable head of the rod in the oil cylinder and the piston which the rod pushes. The spring strength is such that it will yield when pressure is too high, restoring itself to normal length when normal conditions are resumed.

An Automatic Starter for Induction Motors

In a paper recently presented at Chicago before the Association of Iron & Steel Electrical Engineers, H. F. STRATTON, vice-president and chief engineer of The Electric Controller & Manufacturing Company, Cleveland, Ohio, described an automatic starter for squirrel cage alternating-current motors. He said the need of an alternating current automatic motor starter has been clearly shown by the constant demand for something which would do for the squirrel cage motor, what the automatic starter has done for the direct current motor.

Unfortunately, the same advance has not been made in the development of the automatic starter for alternating current motors, although there are more squirrel cage motors in use than any other type of electric motor from the standpoint of numbers and total horsepower.

Speaking generally, the E. C. & M. automatic compensator starts a squirrel cage motor in the usual way, in that the motor initially receives a reduced voltage through a transformer, and after the attainment of considerable speed, the reduced voltage is withdrawn and line voltage is quickly applied to the motor. Beyond this similarity, the compensator differs radically from any existing equipment.

Fig. 1 shows the starter with cover removed. The case is full of oil and the machine itself is built in one unit and fits simply in the case.

Fig. 2 is a three-quartered side elevation, showing the compensator in the "starting" position and Fig. 3 shows it in the off position. T_1 and T_2 are the two coils of an open-delta transformer. The voltage taps from this transformer are brought up to a terminal board which is above the oil level. Any one transformer is

built up entirely of laminations of the same shape and size, so designed that they can be assembled with all joints lapped. The assembled transformer laminations are clamped between the transformer end frames, marked EF_1 and EF_2 .

M is a U-shaped member built up of high-silicon steel laminations which are electrically welded together along six different places on the exterior of the magnetic circuit. Steel plates are also electrically welded to this frame, and are tapped so that, by means of bolts, the magnet may be attached to the main frame of the compensator. Three small horizontal slots and one larger horizontal slot are cut into the upper pole face. The three small horizontal slots are oil canals to permit the armature to open rapidly when the magnet is de-energized. In the large slot is held a copper bar, each end of which is riveted to a brass casting extending upward and supported by a slanting piece of molded asbestos board marked AB . This asbestos board also supports on its under side a cast grid resistance unit. The induced current flows through the copper bar, the two brass castings and the resistance unit when the magnet is in operation, and as this electrical circuit encloses only a portion of the upper pole, there are set up magnetic forces in different sections of the upper pole of the magnet which are out of phase with each other, and which prevent the magnet from chattering.



FIG. 1—COMPENSATOR WITH TOP OF CASE REMOVED

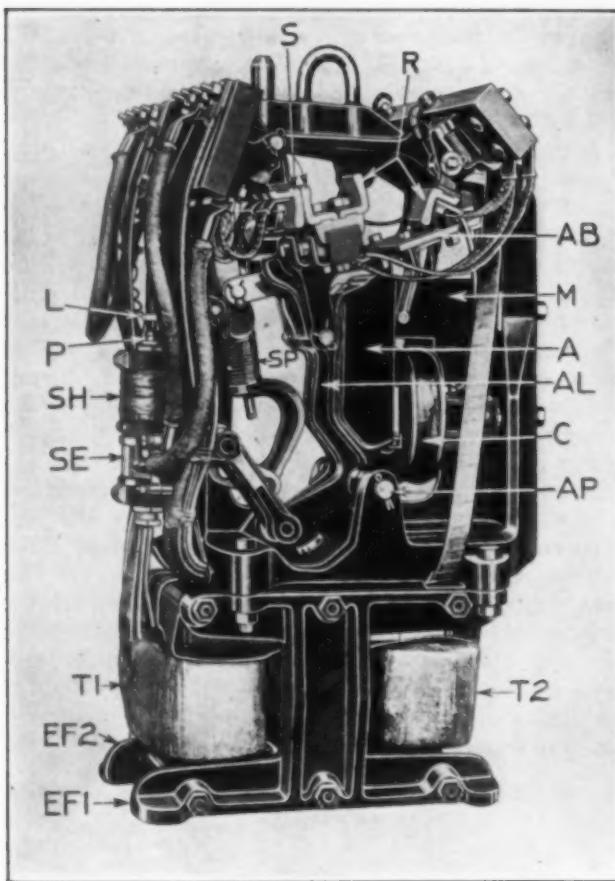


FIG. 2—COMPENSATOR IN STARTING POSITION

The operating coil *C* encloses the lower pole of the magnet, and the wire is wound on a brass spool with supporting lugs.

At the face of the lower pole a strip of non-magnetic metal is loosely supported, forming a gap in the magnetic circuit when the armature is closed. This material is not only non-magnetic, but it also has high ohmic resistance, to reduce the heating and the useless wattage which would be caused by eddy currents which are set up.

The armature, *A*, is also built up of electrically welded steel laminations, and it is welded to the cast steel armature lever, *AL*, which is pivoted to the frame by means of the phosphor bronze rod, *AP*.

It will be noticed that there is only one operating magnet for the entire mechanism, and that this one magnet, when energized, must establish the starting connections and, after a delay, allow the starting connections to be broken and the running connections to be established. This is accomplished by an interesting mechanical movement. With the armature in its closed position, as shown in Fig. 2 it will be noticed that the contacts, *S*, are in engagement, establishing the starting connections to the motor, and that the spring, *SP*, has been compressed. The compensator remains in this starting position until it is released by the action of the transition relay. Its plunger, *P*, lifts when the starting current in the motor drops to a value which is suitable for a change in motor connections from the transformer to the line. When the transition relay operates, it raises the pivoted latch lever, *L*. This movement of the latch lever permits the compression spring, *SP*,

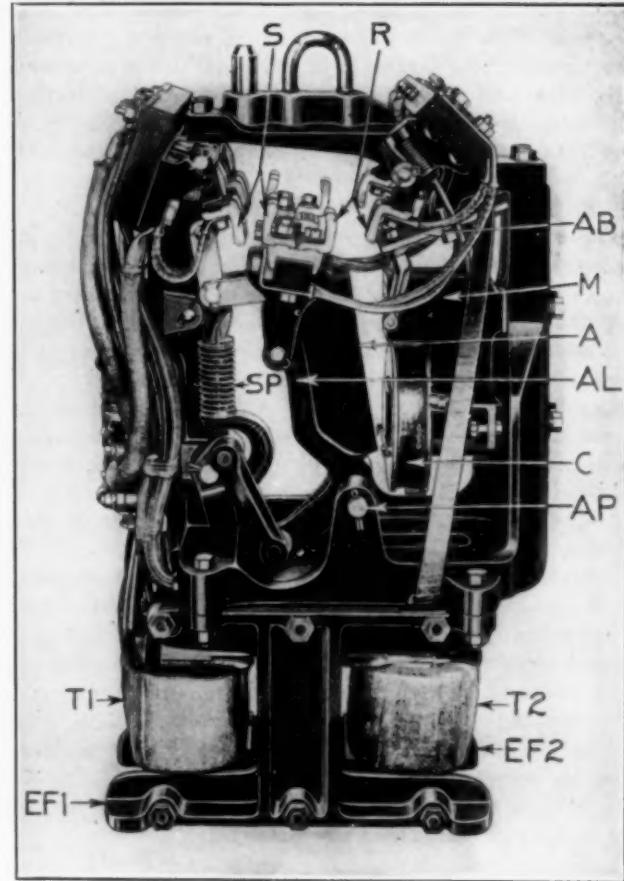


FIG. 3—COMPENSATOR IN OFF POSITION

to act on a toggle joint, quickly throwing the movable contacts from the starting side to the running side; in other words, the motor is disconnected from the transformer and is connected to the line. When it is desired to stop the motor, with the compensator in either the starting or running position, the operating magnet is de-energized and all parts fall into the "off" position, shown in Fig. 3.

The following is a brief summary of the sequence of operations:

First, the operating magnet is excited, closing the armature, compressing a spring and connecting the motor to the source of supply through the transformer; second, after the motor has attained a suitable speed, the transition relay operates a latch, permitting the compression spring to disconnect the motor from the transformer and the transformer from the line and to connect the motor to the line; third, when the operating magnet is de-energized, the armature falls open and the motor is disconnected from the supply lines.

The transition relay shown in Fig. 2 includes a top shunt coil, *SH*, tending to lift the plunger, *P*, when energized, and a bottom coil, *SE*, in series with the motor in starting, tending to hold the plunger down when energized.

The transition relay is self-adjusting, in that the selection of the voltage taps also selects the right adjustment for the operation of the transition relay. In other words, the higher the voltage tap selected, the higher will be the value of motor-starting current at which the relay functions.

Personal

Mr. James J. Bajda, formerly chief dye chemist and chemical engineer for B. Heller & Co., has associated himself with the Block Chemical Laboratories, where he will have charge of their many dye plants now under construction.

Mr. R. A. Bull, formerly of the Chicago Steel Foundry, is now vice-president and general manager of the Duquesne Steel Foundry Co. His headquarters are in the Arrott Building, Pittsburgh, Pa.

Prof. William Campbell of Columbia University, New York, is now serving as consulting metallurgist at the New York navy yard.

Mr. J. D. Collier, director of L. J. Healing & Co., Ltd., Tokyo, engineers and contractors, is visiting America on a short business trip and expects to arrive in New York the first week in August. His address is c/o W. J. Sparks, Inc., 17 Battery Place, New York.

Prof. C. E. Davis has resigned as professor of chemistry at the Utah Agricultural College at Logan, and accepted a position as research chemist for the National Biscuit Co., with headquarters in the Havemeyer Laboratory, Columbia University.

Mr. H. M. Deavitt, consulting chemist, with offices and laboratories in the Rookery, Chicago, Ill., has been elected a director of the Mechanics and Traders' State bank.

Mr. George B. Hogaboom, formerly plater with the International Silver Co., Meriden, Conn., has joined the research forces of the Scovill Manufacturing Co., Waterbury, Conn.

Messrs. Henry D. Lindsley and Thomas C. Desmond announce the organization of their business as investment bankers and engineers under the name of Lindsley, Desmond & Co., Inc., 31 Nassau Street, New York City.

Mr. R. M. Klein has been appointed sales manager of the International Oxygen Co., with headquarters at the company's main office, 115 Broadway, New York. Mr. Klein was formerly an engineer in U. S. Government employ, salesman and sales manager for the Diehl Manufacturing Co. and manufacturers' representative handling a number of mechanical lines. He entered upon his new association on July 1.

Mr. A. W. Phillips, for the past year general superintendent of the Aetna Chemical Co.'s Canadian smokeless powder plant at Drummondville, P. Q., has resigned this position to accept immediately the superintendency of the Canadian Electro-Products Co.'s synthetic acetone plant at Shawinigan Falls, Quebec. R. A. Lockerby, who has been the operating superintendent at Drummondville, succeeds Mr. Phillips in the position. Mr. Phillips formerly was superintendent of the Aetna Explosive Co.'s guncotton plant at Gary, Ind.

Mr. Forest Rutherford, for many years superintendent of Reduction Works for the Copper Queen Consolidated Mining Co. at Douglas, Ariz., severed his connections with the company on June 1 and will go into business for himself as a consulting metallurgical engineer. His present address is c/o First National Bank, Pueblo, Col.

Obituary

Prof. K. Birkeland of Christiania, the eminent Norwegian engineer who developed, in conjunction with Dr. Sam Eyde, the well-known Birkeland-Eyde nitrogen fixation process, passed away in Tokyo on June 18.

Professor Birkeland, who was born in December, 1867, was educated at the University of Christiania, and subsequently studied in Paris, Geneva and Bonn. In 1898 he became professor of physics at the University of Christiania, but prior to this he contributed a number of interesting papers on electric waves, on cathode rays and on atmospheric electricity to "Wiedemann's Annalen," the "Comptes Rendus," etc. On three occasions he got together and led expeditions for studying the polar aurora and magnetic disturbances, and the results of these expeditions have been published in Christiania and London. During some experiments in 1903 he discovered a special electric high-tension "disk flame." From this as a starting point, he and Dr. S. Eyde worked out a practical method for the production of nitrates from the air and as a result great factories for developing this process have been erected in Norway.

The results of this work were completely described in our Volumes II, III and IV, including a paper read before the Faraday Society by Professor Birkeland in 1906.

The Société Norvégienne de l'Azote et de Forces Hydro-Electriques are the owners of the Birkeland-Eyde patents, and at the beginning of 1908 the great Notodden-Svalgfos works were opened with 40,000 hp. Subsequently the company constructed works at Lienfoss (15,000 hp.) and Wamma (55,000 hp.). With the Badische Anilin and Soda Fabrik, and two other German companies which possess their own method (the Schonherr), the Norwegian Nitrate Company has formed subsidiary companies which possess plants at Rjukan (227,000 hp.), Tyin (81,000 hp.) and Matre (83,000 hp.). Professor Birkeland was an honorary member of several learned societies.

CURRENT MARKET REPORTS

The Iron and Steel Market

The pig iron, unfinished steel and finished steel markets have come to a dead stop. In finished steel the buying had been of diminishing volume since April, the forward deliveries being more and more neglected while the early deliveries were largely unobtainable. The pig iron market had seen its greatest activity and its last price advances in June. Then, after the iron and steel price-control feature had been dropped from the food bill in the Senate, President Wilson published his statement urging mine owners and manufacturers to "forego unusual profits" and enunciating the "one price for all" doctrine, i.e., for the Government, its Allies, and the general public. Business, already of small proportions, then ceased altogether.

That was a very easy thing for the market to do in a period of heavy demand. When times are dull no one buys ahead and if operations are at only one-half capacity it is necessary for business to be done almost every day. When everyone has bought far ahead, consumers are covered and producers' order books are filled, it is not necessary for new business to be done.

It was a combination of influences that brought the market to a stop. In the first place, prices had gone altogether too high all along the line. In the second place, there were no longer any prices for finished steel products for regular forward delivery. The Steel Corporation subsidiaries practically withdrew from the market in April, and afterward the quoted prices advanced, but they were really prices for early deliveries, what would be called premium prices if there were regular forward prices with which to compare them. In the third place, jobbers and manufacturing consumers became doubtful what their requirements really would be six months or more hence, with the country at war, labor scarce, and conditions generally changed. In the fourth place, Government fixing of prices was more or less expected either in the near or more distant future. Finally, President Wilson enunciated the "one price for all" doctrine, and that was the last thing needed to cause buyers to decide to stop and await developments.

Even if there were no influence whatever from Washington, the course of the market would be one of no activity for a period of months, except for occasional odd-lot buying, until a new price level should be established. On such an occasion in the past prices have dropped to a point not far from the cost of production, buying being then resumed and being stimulated by the price advances that would follow. In present circumstances the case is different. The mills are not sold as far ahead as they usually become on such a protracted price advance as that of the past two years and a half, partly because they have been reserved in their sales policy and partly because buyers have also been reserved during the past few months.

There are various influences from Washington, however. The Government is to make large purchases of steel for itself and its allies. How large these purchases will be no one ventures now to predict, but the estimates of 30 days or more ago, that they may run to 40 or 50 per cent of the productive capacity, now seem to be rather high. It is no longer to be considered a foregone conclusion that they will take up the slack that is to be produced by a lighter scale of buying by the general public. The Bridge Builders' and Structural Society, for instance, reported that the fabricated steel bookings in June represented only 47½ per cent of a month's fabricating capacity, against 56½ per cent for May, also a small amount. The railroads have ceased buying entirely.

Another influence from Washington is the fixing of prices on steel for the Government. These prices are expected to be made within a few weeks, orders placed meanwhile being subject to the price to be set later. Last March, when special prices for the Government were under discussion, there were many steel manufacturers who objected on the ground that to give the Government a special price would mean that the whole market would work down to that level. Now, when it is settled that the Government is to have a special price, they doubtless prefer to express another view, but President Wilson has thrown the weight of his influence in the direction of one price for all. If the buyers also adopt his view they may be as successful in getting the market down as they have hitherto been in working it up, for it was chiefly competition among buyers, when mills professed an indisposition to sell far ahead, that produced most of the advance in the market.

The only prices that can be quoted for the market

are prices for delivery in the next few months, which very few mills can compass, the following figures giving a rough idea: Bars, 4.50c. to 5c.; structural shapes, 4.50c. to 6c.; plates, 9.50 to 10c.; blue annealed and black sheets, 9c.; galvanized sheets, 11c. to 12c.; steel pipe, 42 per cent off list; nails, \$4 per keg.

PIG IRON

The pig iron markets have come to a complete halt. Unlike the finished steel market, pig iron was being sold for regular forward deliveries, at prices substantially the same as those ruling on small lots for early shipment. On the prices ruling since late in June a little iron has been sold for the remainder of this year, with a considerable tonnage for the first half of 1918. The furnaces are sold up practically full for the remainder of this year, and to the extent of perhaps 40 or 50 per cent of their output for the first half of next year. In the second half of July there has been scarcely any business done. The fact that furnaces have not reduced asking prices is no evidence that they do not expect lower prices. It is never productive of business to cut prices after such an advance. Prices at all northern furnaces are a trifle above \$50, at furnace, while Alabama iron is a shade under \$50.

Non-Ferrous Metal Market

Wednesday, July 25.—There was very little activity in any of the metal markets during the past two weeks owing to the fear of Government regulation of prices. Labor troubles in the West are still holding up production. Copper is considerably lower and lead is lower in the outside market. Tin is virtually unchanged and spelter fractionally lower.

Copper.—The copper market has been very dull and little business has been done. Lake has dropped from 28.50 to 25.50 and electrolytic has dropped from 29.00 to 26-26.50. Some business has probably been done at slightly lower figures than this.

Tin.—About the only thing of importance in the tin market has been the scarcity of spot Straits, the price of which is now 62.50, or about ½ cent higher than on July 16. Tin is coming in regularly without loss. Chinese and Banca tin are slightly lower.

Lead.—The feature of the lead market has been the selling by independents at prices ranging down to 10.00 cents. The demand has been very poor. Labor troubles are still holding up production in the West, and on July 23 a slightly firmer tone reigned on this account.

Spelter.—The price of prompt spelter has remained virtually unchanged with fractional variations up and down. It is now about 8.60 New York. The market has been very dull.

OTHER METALS

Antimony, Chinese and Japanese.....	lb.,	\$0.15
Aluminum, No. 1 Virgin, 98-99 per cent.....	lb.,	.54
Magnesium, metallic	lb.,	2.00-2.50
Nickel, electrolytic	lb.,	.00
Cobalt	lb.,	2.70
Cadmium	lb.,	1.50
Quicksilver	flask,	115.00
Silver	oz.,	.78%
Platinum, pure	oz.,	105.00
Palladium	oz.,	110.00

Chemical Market

COAL TAR PRODUCTS.—The past fortnight has witnessed a generally slow and easier market for practically all items under this classification and the usual

quietness incident to midsummer has prevailed. Stocks have accumulated in most cases and consumers have, as is usual in a weak market, shown little if any desire to buy.

Benzol.—Reports from practically all factors indicate rather ample supplies of benzol for nearby deliveries and with the basic material for the majority of coal tar products showing a tendency to weakness the general line of subsidiary products reflected this condition. Sales during the two weeks have been strictly confined to actual wants of buyers who are not inclined to purchase ahead in view of the easy tendency prevailing. On contracts there is a tendency on part of firms controlling supplies to hold off and business of this character has been unimportant.

Toluol.—The conditions governing benzol have found reflection in the market for next higher fraction to a minor degree however. Spot supplies have accumulated somewhat but important quantities of toluol are not generally reported in dealers' hands for immediate shipment. Spot values have receded somewhat and minor contracts covering deliveries for the next two months have been put through at very attractive figures. Contracts, however, are difficult to secure. Most firms in control of supplies are well sold. Several inquiries are in the market for large quantities but in view of the uncertainty as to the desires of the government these have not been closed.

Phenol.—A weak market continues and there does not appear to be any immediate hopes of relief for the manufacturer. A large production continues and this bears prices. Consuming demand from domestic sources is meagre and the only important transaction noted lately was for a large shipment to the Orient which was placed at the lowest figure so far prevailing this year.

Benzoic Acid.—The production continues at such an unusual extent that prices have sagged to the lowest level that has prevailed since the beginning of the war. Offers have been made under the \$4 mark but it is rumored that manufacturers in their own interest will curtail the output which seems to be in excess of the consumption. The same conditions prevail in the market for *Benzoate of Soda*.

H Acid.—The entry of several new producers into the manufacture of this product has not so far resulted in lower prices. A firm of substantial standing is offering the product at $4\frac{1}{2}$ cents per unit, material generally testing 82 per cent. This price, however, brings the cost of direct colors to a level that will allow of but limited competition with the large, old established firms producing their own H acid.

Gamma Acid.—There has been a production in a liquid form of this material in the Middle West for the consumption of the producer. It is now stated that a dry salt will shortly be marketed by this firm and in addition at least one other producer will shortly be in position to deliver.

Paramidophenol.—A larger production of this material is noted and while the older manufacturers are holding to previous quotations the new operators are cutting prices. The same conditions seem to prevail with *paraphenylenediamine*.

Salicylic Acid.—In contrast to other coal tar products the demand for this product has probably exceeded the supply one hundred to one. Production is centered in few hands but active and rapid preparation is being

made to increase the output and the market will probably go through the same process of elimination noted last year. This condition prevails in *salicylate of sodium* and *salol*.

HEAVY CHEMICALS.—The weakness in the market for *bleaching powder* seems to be the outstanding item of interest during the two weeks. Prices have sagged and sagged until the bottom more than dropped out. The product is a difficult one to move in the summer but no one expected a price that closely approximated pre-war times. *Caustic soda*, however, after a temporary weakness of one or two days strengthened and prices are again higher. This product continues to be the item of most interest to the chemical speculator. *Soda ash* has revealed firmness especially in futures. Spot supplies have been meagre and the demand has been rather urgent. *Copper sulphate* has moved slowly with a tendency to improve as we write. Prices are quietly firm. *Cyanides* are easier and not in special demand. Imports from England are somewhat heavier than usual. *Chlorates* have remained neglected. Domestic business is obtainable on a basis equal to that for export, so anxious are holders for business. *Epsom salts* are somewhat easier and supplies are more easily secured. *Formaldehyde* after a long period of firmness has eased off but supplies are not by any means large. *Phosphorus compounds* have continued scarce and high but a few cases have generally been obtainable from time to time. *Sodium nitrite* has remained practically out of the market and sales have passed above the 50c. level. This compares with a normal price of about 6c. Several productions are planned and contracts are being offered. *Nitrate of Soda* has sold at a record price and importers continue to express bullish views. *Sulphate of ammonia* has been practically eliminated from the market aside from contract business. An offer of 100 tons is very unusual. Prices have soared to unheard-of levels.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 23, 1917

Acetic anhydride.....	lb. 1.70	—	1.90
Acetone, drums.....	lb. .32	—	.33
Acid, acetic, 28 per cent.....	lb. .05	—	.05 $\frac{1}{2}$
Acetic, 56 per cent.....	lb. .10	—	.11
Acetic, glacial, 99 $\frac{1}{2}$ per cent, carboys.....	lb. .34	—	.35
Boric, crystals.....	lb. .13	—	1.3 $\frac{1}{2}$
Citric, crystals.....	lb. .72 $\frac{1}{2}$	—	.73
Hydrochloric, commercial, 18 deg.....	lb. .01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Hydrochloric, 20 deg.....	lb. .01 $\frac{1}{4}$	—	.02
Hydrochloric, C. P., conc., 22 deg.....	lb. .02	—	.02 $\frac{1}{4}$
Hydrofluoride, 30 per cent, in barrels.....	lb. .04 $\frac{1}{4}$	—	.05
Lactic, 44 per cent.....	lb. .11	—	.12
Lactic, 22 per cent.....	lb. .04 $\frac{1}{2}$	—	.05
Nitric, 36 deg.....	lb. .06	—	.06 $\frac{1}{2}$
Nitric, 42 deg.....	lb. .08	—	.08 $\frac{1}{4}$
Oxalic, crystals.....	lb. .45	—	.46
Phosphoric, 88 per cent.....	lb. .33	—	.37
Picric.....	lb. .70	—	.75
Pyrogallic, resublimed.....	lb. 3.50	—	4.00
Sulphuric, 60 deg.....	ton 19.00	—	21.00
Sulphuric, 66 deg.....	ton 29.00	—	30.00
Sulphuric, oleum (Fuming), tank cars.....	ton 38.00	—	40.00
Tannic, U. S. P., bulk.....	lb. .95	—	1.00
Tartaric, crystals.....	lb. .79	—	.81
Tungstic, basic 100 per cent.....	lb. 1.80	—	—
Alcohol, grain, 188 proof.....	gal. 4.00	—	4.02
Alcohol, wood, 95 per cent.....	gal. 1.00	—	1.02
Alcohol, denatured, 180 proof.....	gal. 1.00	—	1.02
Alum, ammonia lump.....	lb. .04 $\frac{1}{4}$	—	.04 $\frac{1}{4}$
Alum, chrome ammonium.....	lb. .19	—	.20
Alum, chrome potassium.....	lb. .30	—	.32
Alum, chrome sodium.....	lb. .12	—	.12 $\frac{1}{2}$
Alum, potash lump.....	lb. .07 $\frac{1}{2}$	—	.08
Aluminum sulphate, technical.....	lb. .02	—	.02 $\frac{1}{4}$
Aluminum sulphate, iron free.....	lb. .03	—	.03 $\frac{1}{4}$
Ammonia aqua, 26 deg. carboys.....	lb. .07	—	.07 $\frac{1}{2}$
Ammonium carbonate.....	lb. .13	—	.14
Ammonium nitrate.....	lb. .16	—	.17
Ammonium, sulphate domestic.....	100 gal. 6.25	—	6.35
Amyl acetate.....	gal. 4.50	—	4.60
Arsenic, white.....	lb. .17	—	.18
Arsenic, red.....	lb. .50	—	.60
Barium chloride.....	ton 90.00	—	100.00
Barium sulphate (Blanc Fixe, powder).....	lb. .04	—	.04 $\frac{1}{2}$
Barium nitrate.....	lb. .10 $\frac{1}{2}$	—	.11
Barium peroxide, 80 per cent.....	lb. .28	—	.30

Bleaching powder, 35 per cent chlorine.....	lb. .01 ¹ / ₂ — .01 ¹ / ₂	Beta naphthal benzoate.....	lb. 8.50 — 9.00
Borax, crystals, sacks.....	lb. .07 ³ / ₄ — .08	Beta naphthal, sublimed.....	lb. .75 — .76
Brimstone, crude.....	ton 50.00 —	Beta naphthylamin e.c.m.....	lb. 2.50 —
Bromine, technical.....	lb. .80 — .90	Dichlor benzol.....	lb. .11 — .20
Calcium acetate, crude.....	per 100 lb. 5.25 — 5.30	Dinitrochlorbenzol.....	lb. .44 — .46
Calcium carbide.....	ton 80.00 — 90.00	Dimethylaniline.....	lb. .58 — .60
Calcium chloride, 70-75 per cent, fused, lump.....	ton 30.00 — 31.00	Diphenylamine.....	lb. .95 — 1.00
Calcium peroxide.....	lb. 1.60 — 1.65	H-acid.....	lb. 3.25 — 3.50
Calcium phosphate.....	lb. .30 — .31	Metaphenylenediamine.....	lb. 1.75 — 1.80
Calcium sulphate.....	lb. .10 — .12	Monochlorbenzol.....	lb. .22 — .23
Carbon bisulphide.....	lb. .06 ¹ / ₂ — .07	Naphthalene, flake.....	lb. .09 — .09 ¹ / ₂
Carbon tetrachloride, drums.....	lb. .16 — .16 ¹ / ₂	Naphthionic acid, crude.....	lb. 1.50 — 1.75
Claustic potash, 88-92 per cent.....	lb. .85 — .87	Nitro naphthaline.....	lb. .45 — .50
Claustic soda, 76 per cent.....	lb. .07 ¹ / ₂ — .07 ¹ / ₂	Nitro toluol.....	lb. .50 — .55
Chlorine, liquid.....	lb. .15 — .40	Ortho-amidophenol.....	lb. — —
Cobalt oxide.....	lb. 1.60 — 1.65	Ortho-toluidine.....	lb. .90 — 1.00
Copperas.....	100 lb. 1.00 — 1.05	Para-amidophenol, base.....	lb. 5.00 — 6.00
Copper carbonate.....	lb. .32 ¹ / ₂ — .35	Paranitraniline.....	lb. 1.05 — 1.10
Copper cyanide.....	lb. .72 — .74	Paraphenylenediamine.....	lb. 3.50 — 3.75
Copper sulphate, 99 per cent, large crystals.....	lb. .09 ¹ / ₂ — .09 ³ / ₄	Para toluidine.....	lb. 1.85 — 2.10
Cream of tartar, crystals.....	lb. .48 ¹ / ₂ — .50	Phenol, U. S. P.....	lb. .40 — .42
Epsom salt, bags.....	100 lb. 3.75 — 4.00	Resorcin, technical.....	lb. 8.00 — 9.00
Formaldehyde, 40 per cent.....	lb. .17 — .18	Resorcin, pure.....	lb. 14.00 — 15.00
Glauber's salt.....	100 lb. .72 — .80	Salicylic acid.....	lb. 1.50 — 1.75
Glycerine, bulk, C. P.....	lb. .62 ¹ / ₂ — .63	Salol.....	lb. 1.85 — 2.00
Iodine, resublimed.....	lb. 4.25 —	Sulphanilic acid.....	lb. .32 — .33
Iron oxide.....	lb. .02 — .08	Tolidin.....	lb. 3.00 —
Lead, acetate, white crystals.....	lb. .16 — .17	Toluidine-mixture.....	lb. 75 — .85
Lead arsenate.....	lb. .12 ³ / ₄ — .13 ¹ / ₂		
Lead nitrate.....	lb. .17 ¹ / ₂ — .18		
Litharge, American.....	lb. .08 — .19		
Lithium carbonate.....	lb. 1.02 — 1.05		
Manganese dioxide, U. S. P.....	lb. .45 — .55	Pennsylvania.....	bbl. 3.10 —
Magnesium carbonate, tech.....	lb. .13 ¹ / ₂ — .14	Corning, Ohio.....	bbl. 2.40 —
Nickel salt, single.....	lb. .14 — .14 ¹ / ₂	Somerset, Ky.....	bbl. 2.20 —
Nickel salt, double.....	lb. .11 — .12	Wooster, Ohio.....	bbl. 2.18 —
Phosphorus, red.....	lb. 1.18 — 1.20	Indiana.....	bbl. 1.78 —
Phosphorus, yellow.....	lb. 2.45 — 2.50	Illinois.....	bbl. 1.92 —
Potassium bichromate.....	lb. .35 ¹ / ₂ — .36	Oklahoma and Kansas.....	bbl. 1.70 —
Potassium bromide granular.....	lb. 1.35 — 1.40	Caddo, La., light.....	bbl. 1.90 —
Potassium carbonate calcined, 80-85 per cent.....	lb. .70 — .75	Corsicana, Tex., light.....	bbl. 1.70 —
Potassium chlorate, crystals.....	lb. .49 — .50	California.....	bbl. .98 — 1.29
Potassium cyanide, 98-99 per cent.....	lb. 2.30 — 2.50	Gulf Coast.....	bbl. 1.00 —
Potassium iodide.....	lb. 2.90 — 2.92		
Potassium muriate 80-82 p. c. basis of 80 p. c.....	ton 350.00 — 360.00		
Potassium nitrate.....	lb. .31 — .33		
Potassium permanganate.....	lb. 4.00 — 4.10	Black, reduced, 29 gravity, 25-30 cold test.....	gal. 13 ¹ / ₂ — .14
Potassium prussiate, red.....	lb. 2.50 — 2.55	Cylinder, light.....	gal. .21 — .26
Potassium prussiate, yellow.....	lb. 1.05 — 1.10	Cylinder, dark.....	gal. .18 — .19
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton 325.00 — 350.00	Paraffine, high viscosity.....	gal. 29 ¹ / ₂ — .30
Rochelle salts.....	lb. .39 — .39 ¹ / ₂	Paraffine, 903 sp. gr.....	gal. 21 ¹ / ₂ — .22
Sal ammoniac, gray gran.....	lb. .10 — .11	Paraffine, 865 sp. gr.....	gal. 18 ¹ / ₂ — .19
Sal ammoniac, white gran.....	lb. .15 — .16		
Sal soda.....	100 lb. 1.15 — 1.25		
Salt cake.....	100 lb. .90 — 1.00		
Silver cyanide.....	oz. —		
Silver nitrate.....	oz. .50 — .52		
Soda ash, 58 per cent, light, flat.....	100 lb. 2.80 — 2.90	Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal. .52 —
Soda ash, 58 per cent, dense, flat.....	100 lb. 3.65 — 3.75	Pine oil, destructively distilled, sp. gr. 0.920-0.940.....	gal. .48 —
Sodium acetate.....	lb. .09 — .10	Pine-tar oil, sp. gr. 1.025-1.035.....	gal. 25 ¹ / ₂ —
Sodium benzoate.....	lb. 4.00 — 4.50	Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal. .35 —
Sodium bicarbonate, domestic.....	100 lb. 2.35 — 2.50	Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works.....	gal. .37 —
Sodium bicarbonate, English.....	lb. —	Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....	gal. .26 —
Sodium bichromate, powd.....	lb. .15 ³ / ₄ — .16	Pine tar, thin, sp. gr. 1.060-1.080.....	gal. .22 —
Sodium chlorate.....	lb. .03 ¹ / ₂ — .04	Turpentine, crude, sp. gr. 0.980-1.000.....	gal. .40 —
Sodium cyanide.....	lb. .23 — .25	Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal. .19 —
Sodium fluoride, commercial.....	lb. .52 — .53	Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal. .19 —
Sodium hyposulphite.....	lb. .17 ¹ / ₂ — .18		
Sodium nitrate, 93%.....	100 lb. .01 ¹ / ₂ — .02		
Sodium nitrite.....	100 lb. 4.27 ¹ / ₂ — 4.30	Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal. .52 —
Sodium peroxide.....	lb. .45 — .55	Pine oil, destructively distilled, sp. gr. 0.920-0.940.....	gal. .48 —
Sodium phosphate (tri).....	lb. .04 ³ / ₄ — .05	Pine-tar oil, sp. gr. 1.025-1.035.....	gal. 25 ¹ / ₂ —
Sodium prussiate, yellow.....	lb. .30 — .32	Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal. .35 —
Sodium silicate, liquid—40 deg. Baumé.....	100 lb. 2.00 — 2.50	Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works.....	gal. .37 —
Sodium sulphide, 30 per cent crystals.....	100 lb. 2.00 — 2.10	Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....	gal. .26 —
Sodium sulphide, 60 per cent, fused.....	100 lb. 3.00 — 3.50	Pine tar, thin, sp. gr. 1.060-1.080.....	gal. .22 —
Sodium sulphite.....	lb. .03 ¹ / ₂ — .03 ¹ / ₂	Turpentine, crude, sp. gr. 0.980-1.000.....	gal. .40 —
Strontium nitrate.....	lb. .28 — .30	Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal. .19 —
Sulphur chloride, drums.....	lb. .06 — .06 ¹ / ₂	Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal. .19 —
Sulphur dioxide, liquid, in cylinders.....	lb. .15 — .40		
Sulphur, flowers, sublimed.....	100 lb. 3.95 — 4.10		
Sulphur, roll.....	100 lb. 3.70 — 3.85		
Sulphur, crude.....	ton 50.00 — 55.00		
Tin dichloride, 50 deg.....	lb. .19 ¹ / ₂ — .19 ¹ / ₂		
Tin oxide.....	lb. .64 ¹ / ₂ — .65		
Zinc carbonate.....	lb. .25 — .27		
Zinc chloride.....	lb. .10 ⁴ / ₅ — .11		
Zinc cyanide.....	lb. .50 —		
Zinc dust, 350 mesh.....	lb. .17 — .17 ¹ / ₂		
Zinc oxide, American process XX.....	lb. .14 ¹ / ₂ — .15		
Zinc sulphate.....	lb. .05 ¹ / ₂ — .06		

Coal Tar Products (Crude)

Benzol, pure, water white.....	gal. .53 — .55
Benzol, 90 per cent.....	gal. .53 — .55
Toluol, pure, water white.....	1.70 — 1.80
Xylool, pure, water white.....	gal. .50 — .55
Solvent naphtha, water white.....	gal. .19 — .23
Solvent naphtha, crude, heavy.....	gal. .13 — .16
Cresote oil, 25 per cent.....	gal. .31 — .33
Dip oil, 20 per cent.....	gal. .28 — .30
Pitch, various grades.....	ton 8.00 — 20.00
Carbolic acid, crude, 95-97 per cent.....	lb. 1.00 — 1.05
Carbolic acid, crude, 50 per cent.....	lb. .55 — .60
Carbolic acid, crude, 25 per cent.....	lb. .32 — .35
Cresol, U. S. P.....	lb. — —

Intermediates, Etc.

Alpha naphthylamin.....	lb. .75 — .80
Aniline oil.....	lb. .29 — .30
Aniline salts.....	lb. .34 — .35
Anthraeoene, 80 per cent.....	lb. .10 —
Benzaldehyde.....	lb. 4.00 — 4.50
Benzidine, base.....	lb. 1.80 — 1.90
Benzidine, sulphate.....	lb. 1.55 — 1.60
Benzoic acid.....	lb. 4.50 — 4.75
Benzyl chloride.....	lb. 1.75 — 2.00

Petroleum Oils

Crude (at the Wells)

Pennsylvania.....	bbl. 3.10 —
Corning, Ohio.....	bbl. 2.40 —
Somerset, Ky.....	bbl. 2.20 —
Wooster, Ohio.....	bbl. 2.18 —
Indiana.....	bbl. 1.78 —
Illinois.....	bbl. 1.92 —
Oklahoma and Kansas.....	bbl. 1.70 —
Caddo, La., light.....	bbl. 1.90 —
Corsicana, Tex., light.....	bbl. 1.70 —
California.....	bbl. .98 — 1.29
Gulf Coast.....	bbl. 1.00 —

Lubricants

(Prices at New York)

Black, reduced, 29 gravity, 25-30 cold test.....	gal. 13 ¹ / ₂ — .14
Cylinder, light.....	gal. .21 — .26
Cylinder, dark.....	gal. .18 — .19
Paraffine, high viscosity.....	gal. 29 ¹ / ₂ — .30
Paraffine, 903 sp. gr.....	gal. 21 ¹ / ₂ — .22
Paraffine, 865 sp. gr.....	gal. 18 ¹ / ₂ — .19

Vegetable and Other Oils

China wood oil.....	lb. .17 — .19
Cottonseed oil, crude.....	gal. 1.07 —
Linseed oil, raw, cars.....	gal. 1.11 —
Peanut oil, crude.....	gal. 1.15 —
Rosin oil, first run.....	gal. .39 —
Rosin oil, fourth run.....	gal. .66 —
Soya bean oil, Manchuria.....	lb. 14 ¹ / ₂ —
Turpentine, spirits.....	gal. .42 —

Miscellaneous Materials

Barytes, floated, white, foreign.....	ton 38.00 — 40.00
Beeswax, white, pure.....	lb. .60 — .65
Carnauba wax, flor.....	lb. .53 —
Casein.....	lb. .19 — .28
Chalk, light, precipitated, English.....	lb. .03 — .06
Feldspar.....	ton 8.00 — 12.00
Fuller's earth, powdered.....	100 lb. 1.00 — 1.50
Ookerite, crude, brown.....	lb. .60 — .70
Ookerite, American.....	lb. .35 —
Red lead, dry, carloads.....	lb. .13 —
Rosin, 280 lb.....	bbl. 5.70 —
Soapstone.....	ton 10.00 — 12.50
Talc, American, white.....	ton 10.00 — 13.00
White lead, dry.....	ton 10.00 — 13.00

Refractories, Etc.

(F.O.B. Works)

Chrome brick.....	net ton Nominal
Chrome cement, Grecian.....	ton 45.00 — 50.00
Clay brick, 1st quality fireclay.....	per 1000 30.00 —
Clay brick, second quality.....	per 1000 30.00 —
Magnesite, raw.....	ton 40.00 — 35.00
Magnesite, calcined.....	ton 40.00 — 55.00
Magnesite, Grecian, dead burned.....	net ton 90.00 —
Magnesia brick, Grecian, 9x4 ¹ / ₂ x2 ¹ / ₂	net ton 140.00 —
Silica brick.....	per 1000 50.00 —

Ferroalloys

Ferrocobaltitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.....	ton 160.00 —
Ferrocanganese.....	ton 400.00 — 425.00
Ferromanganese, English.....	ton 200.00 —
Ferromolybdenum, per lb. of Mo.....	lb. 4.50 —
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....	ton 200.00 — 225.00
Ferrosilicon, 50 per cent, contract.....	ton 100.00 —

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

Aniline Bases Co., 1 Newark Street, Hoboken, N. J., \$120,000. Manufacturing dyes, chemicals, etc.

Arkansas City Refining Company, Wilmington, Del., \$500,000. Incorporators: Harry Emmons, Kenneth L. Emmons, Anna L. Dorsey, of Wilmington.

Bookertee Smelting & Refining Co., Henryetta, Okla., \$1,000,000. Incorporators: F. R. Bouldin, S. Walker and V. V. Grant, of Bouldin.

The C. P. N. Chemical Company, New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals. H. M. Peyster, G. D. Aranow and A. N. Harris, 320 Broadway, are the incorporators.

The Charleston Alloy Steel Company, Belle, W. Va., has been incorporated with a capital of \$500,000, to operate a local plant. J. M. Payne, Berkeley Minor, Jr., and G. P. Brennan, all of Charleston, are the incorporators.

The Chemical Apparatus Manufacturing Company, Wilmington, Del., has been incorporated with a capital of \$150,000 to manufacture chemicals. C. L. Rimlinger, and Henry M. Robinson, Wilmington; and Clement M. Egner, Elkton, Md., are the incorporators.

Chicago—Miami Lead & Zinc Co., Miami, \$450,000. Incorporators: Wallace E. Shirra, Claude K. Church, Chicago; Charles McCafferty, Oklahoma City.

Corona Salt Co., Inc., Groton, N. Y., \$425,000. Oil, gas and salt production. Incorporators: F. R. Miller, 120 East Eighty-ninth Street, New York City; E. A. King, 1215 Union Avenue, Bronx; S. M. Bell, Montclair, N. J.

The Dittenhofer Tube & Rubber Company, New York, has been incorporated in Delaware with capital of \$1,000,000, to manufacture automobile tires and tubing. Arthur W. Britton, Samuel B. Howard and John A. Moore, all of New York City, are the incorporators.

The Durham Paper & Pulp Company, Phillipsburg, N. J., has been incorporated with a capital of \$125,000, to operate a local plant. Walter L. Cochran, O. S. McConnell and E. Hulings Antrim are the incorporators.

East Chicago Foundry Company, East Chicago, Ind., \$30,000, foundry. Directors: Harry C. Stuart, Henry S. Evans, Phillip S. Graver, William F. Graver.

The Franklin Paint Co., Cleveland, Ohio, \$10,000. F. H. Meier and others, incorporators.

The Great Western Potash Company, San Diego, Cal., has been incorporated in Delaware with a capital of \$1,000,000, to manufacture potash and aluminum. J. A. and E. M. Henry, and W. E. Shaw, all of San Diego, are the incorporators.

Havemeyer-Seamans Oil Company, \$10,000,000, acquire oil and gas lands and develop the same, construct railroads, etc. Incorporators: C. L. Rimlinger, Henry M. Robinson, Clement M. Egner, Wilmington, Del.

Independent American Oil & Sulphur Corporation, Wilmington, Del., \$15,000,000. Incorporators: A. M. Holleran, M. H. Morris, Ferris Giles of Wilmington.

Kentucky Oil Company, Ashland, \$200,000. Incorporators: Marshall Bond, Henry F. Benn, Frank M. Laird and C. C. McCoc.

Joseph G. Kessler & Co., Inc., Brooklyn, N. Y., \$45,000. Smelting and refining zinc ore and its products. Incorporators: J. G. Kessler, B. Goldberg, 105 Kent Street, Brooklyn.

The Keystone Chemical Supply Company, Philadelphia, Pa., has been incorporated with a capital of \$50,000 to manufacture chemicals. G. A. Street is the principal incorporator.

Lambert-Georgian Chemicals Corporation, Manhattan; capital \$100,000. Drugs and chemicals. Frances Kriegel, Maurice Hotchner and Luis F. Cores.

The Lee Paper Box Company, Philadelphia, Pa., has been incorporated with a capital of \$15,000 to operate a local plant. Edwin A. Lee is the principal incorporator.

W. C. McBride, Inc., Wilmington, Del., \$100,000. Petroleum and natural gas. Incorporators: C. L. Rimlinger, Henry M. Robinson, Clement M. Egner.

The Massillon Steel Castings Co., Massillon, Ohio, has been incorporated for \$250,000. The new steel plant will begin operation in a short time.

Montezuma Mining & Reduction Corp., \$1,000,000, do a general mining business in all its branches. Incorporators: M. L. Rogers, H. W. Davis, L. A. Irwin, Wilmington, Del.

Nica Refining Co., Washington, D. C., \$100,000. Incorporators: A. H. Coombs, H. P. Olden, of Washington.

The Oklahoma Consolidated Producing & Refining Co., Wilmington, Del., \$5,000,000. The business of drilling and marketing oil, natural gas, etc.

Ossining Chemical Works, Inc., Ossining, N. Y., \$25,000. Alkalies, drugs, and chemicals. Incorporators: A. F. McCabe, H. W. Bense, H. S. Ferrigro, 37 Wall Street.

The Ouachita Cotton Oil Company, of Camden, Ark., \$60,000 (\$37,000 subscribed). Incorporators: W. H. Warnock, T. S. Grayson, D. P. Baker, W. W. Boyd, A. A. Reid, J. O. Hutcheson, James G. Brown, J. L. Davis and C. W. McKay.

The Penn Paper Products Company, Philadelphia, Pa., has been incorporated with a capital of \$50,000 to manufacture paper goods. LeRoy Jacobs, Philadelphia; Cyrus E. Tomlinson, McKinley, Pa., and George L. Townsend, Jr., Wilmington, Del., are the incorporators.

The Potash Extraction Corporation, New York, N. Y., has been incorporated with a capital of \$100,000, to operate crushing plants and quarries for felspathic rock. G. F. McKay, D. Lillis and A. A. Alexander, 2 Rector Street, are the incorporators.

Priest-Lee-Bell Oil Corporation, Wilmington, Del., \$300,000. To refine, market and develop crude oil and its products.

The Radiant Glass Company of Fort Smith, Ark., \$10,000, filed articles of incorporation. Incorporators: George D. Carnay, M. N. Carney and J. S. Parks.

The Sotter Brass Foundry Company, Pittsburgh, Pa., has filed articles of incorporation with a capital of \$10,000, to operate a local plant. Charles J. Sotter is the principal incorporator.

The Southern Ferro Alloys Company, Chattanooga, Tenn., has been incorporated with a capital of \$200,000, to operate a plant for the production of ferrosilicon, ferrochrome and kindred alloys. It is said that the company has acquired a site for the proposed plant and will commence operations with three electric furnaces. F. J. Kreusi is president of the company.

The Stalnaker Steel Company, Pittsburgh, Pa., has been incorporated with a capital of \$150,000 to operate a local plant. Harvey D. Stalnaker is the principal incorporator.

Standard Asphalt and Refining Company, \$5,000,000, to refine and market oil and products thereof. Incorporators: L. E. Phillips, J. B. Bailey, Dover, Del.

The Standard Tungsten Company, Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture tungsten specialties. R. T. Rodger and G. Dazet, are the principal incorporators. C. H. Vail, 810 Broad Street, is agent for the company.

The Superior Glass Manufacturing Company, Martins Ferry, Ohio, has been incorporated in West Virginia, with capital of \$50,000, to operate a local plant. Frank A. McMahon and R. R. Marshall, Wheeling, and William W. Davis, Cumberland, Md., are the incorporators.

The Sweetser & Bainbridge Metal Alloy Company, Albany, N. Y., has been incorporated with a capital of \$10,000 to manufacture metal alloys and metallic compounds. S. P. Sweetser, E. F. Bainbridge and H. G. Batcheller, Albany, are the incorporators.

The Tennessee Paper Mills Company has been incorporated with a capital of \$200,000 to manufacture paper boxes. The new factory will make two kinds of paper, straw board and chip board.

Transportation Petroleum Company, New York, \$1,000,000: F. Fried, G. M. Healy, New York; Liciam Ross, San Antonio, Tex.

The United States Nitrates & Ammunition Company, New York, N. Y., has been incorporated in Delaware with a capital of \$100,000 to manufacture nitrates of soda products and other specialties. William L. Underwood, Patchogue, L. I.; George E. Wilson, New York; and Elmer E. Fowler, Spencer, N. Y., are the incorporators.

Virginia Chlorine Products Co., Newark, N. J., \$1,500,000, chemicals. Incorporators: Henry Van Arsdale, Jr., Newark; C. J. Kulberg, New York.

The White Chemical Company, Louisville, Ky., has been incorporated with a nominal capital of \$5,000 to manufacture chemicals. J. L. and Emile Steinfeld and W. G. Rork are the incorporators.

Capital Increases

The Erie Iron & Steel Company, Erie, Pa., has increased its capital from \$100,000 to \$500,000.

The Hewitt Rubber Company, 240 Kensington Street, Buffalo, N. Y., has increased its capital from \$1,000,000 to \$1,500,000. The company specializes in the manufacture of air brake hose for locomotive service.

The Buffalo Pressed Steel Company, Buffalo, N. Y., has recently increased its capital from \$30,000 to \$75,000.

The Minotola Glass Company, Minotola, N. J., has increased its capital from \$100,000 to \$500,000 for expansion.

Construction and Operation

California

INDIAN FALLS—The Noble Electric Steel Company, which is already engaged in producing electrically smelted steel in commercial quantities at its plant in Heroult, Shasta County, has taken a lease upon the manganese mining property originally located by Messrs. Mason and Braito, situated at the "watering trough" near Indian Falls.

J. Carey is superintending the development work which is now being started. It is reported that the company intends to build a 700-foot tramway and to prosecute the work with a crew of 30 or 40 men. The manganese property is situated almost on the line of the Indian Valley Railroad.

MARTINEZ—The Shell Oil Refinery will expend \$1,000,000 on its plant. A contract has been let for nine 55,000-barrel steel tanks.

REDDING (Shasta County).—At a special meeting of the directors of Noble Steel Electric Company, operating at Heroult on the Pitt River, W. H. French, vice-president and general manager of the Judson Manufacturing Company, has been elected vice-president and general manager. H. H. Noble, the man who developed the plant at Heroult, retains his stock in the company, but it is understood he has given his proxy to French.

The new general manager has been head of the Judson company for five years and during that time increased the business from one-quarter to three millions a year. Already he has made arrangements with the United States Government to take the ferromanganese, ferrochrome and ferrosilicon being turned out at Heroult.

H. E. Bothin, president of the Judson Manufacturing Company, is backing French in his venture at Heroult.

Dr. W. W. Clark will remain in charge of all plant operations.

The plant now has two furnaces working 24 hours a day; one on ferromanganese, turning out 8 to 10 tons every 24 hours, and the other on ferrosilicon, turning out 5 tons every 24 hours. The company also has ready three small furnaces, each of which will turn out one and a half tons of ferrochrome every 24 hours.

Slow shipments of electrodes from the East and freight tieups have held down production at Heroult, but the railroads have assured the new management that since they are making ferroalloys all materials will be rushed.

SAN BERNARDINO.—Building of a sodium reduction plant in San Bernardino

will begin within a few days. Sodium deposits on the desert will furnish the material.

SAN FRANCISCO.—A \$350,000 refining plant for cocoanut oil is contemplated in San Francisco. Mr. C. E. Johnson of Milwaukee, president of the Johnson Manufacturing Company, is looking for sites.

SAN FRANCISCO.—The Fleischhaker Paper Co. has taken a lease on a 4-story 123 x 130 ft. reinforced concrete factory to be built at Second and Harrison Streets by the Clinton Construction Co. Twenty-first and Treat Streets. It was purchased for \$125,000.

SAN FRANCISCO.—Plans have been completed for the 1-story mill and foundry building to be erected for the Jewell Steel & Malleable Company at Potrero Avenue and Twenty-fifth Street. The building will cover an area of 148 by 108 feet. Further extensions will be erected as soon as this unit has been completed.

SAN FRANCISCO.—Potash is said to be the secret of the recent declaration of a 13 per cent stock dividend to the shareholders of the Santa Cruz Portland Cement Company, on stock of record July 14. A large stockholder of the company said yesterday that the Santa Cruz is now making 600 pounds of potash daily, with only a single unit of an inexpensive plant in place and in operation. This potash is a by-product, extracted from the flux dust and fumes generated in making the cement. It is figured that with eight kilns in operation the company ought to make two tons of potash daily.

Delaware

WILMINGTON.—The Harlan & Hollingsworth Corporation, West Street, has filed plans for the erection of a new copper and tin shop at its shipbuilding plant.

WILMINGTON.—The Wilmington Steel Company, it is said, is planning for the rebuilding of its 18-inch mill and other sections of the plant recently destroyed by fire with loss of about \$150,000. The Midvale Steel Company, Philadelphia, operates this organization.

Florida

JACKSONVILLE.—General Manager J. C. O'Dell of the Municipal Docks and Terminals announced recently that he had concluded arrangements with F. M. Whittle, manager of the Florida division of the Virginia-Carolina Chemical Company, to have the branch plant of that company located on the properties of the Municipal Docks and Terminals near the St. Johns Mill Road. The space will be approximately three acres, and will have buildings on it to cost between \$150,000 and \$250,000. These buildings consist of warehouses and manufacturing plants and an acid tower.

Idaho

WALLACE.—The Tamarack & Custer Mining Company has resumed work on its properties in the Cœur d'Alenes after a lull of three months. The company, which owns a half interest in the smelter at Northport, Wash., according to a report, will send its ore to the Bunker Hill & Sullivan smelter at Kellogg. This move is taken on account of the difficulty in getting coke at Northport.

Illinois

CHICAGO.—The Marks Manufacturing Company will expend \$14,500,000 in the construction of its new steel works at East Chicago, which is \$9,500,000 in excess of the estimated cost a year ago. A 600-ton blast furnace, complete with docks, ore and coke handling machinery, an open-hearth steel department with a capacity of 250,000 gross tons of ingot a year, and a universal plate mill with a capacity of 180,000 gross tons of universal and sheared plates will be added.

Iowa

DES MOINES.—A deal was closed to-day for the purchase of an acre of land at East Twenty-sixth Street and Dean Avenue by the Keith Furnace Company of 336 Southwest Eleventh Street. It is planned to erect a four-story factory and a large one-story foundry, which will be a modern, fireproof, daylight type building. R. S. Keith is owner of the plant.

Kentucky

HELLIER.—The Allegheny Coke Company is reported to be planning for the installation of a new battery of coke ovens

to double the present output, making a total capacity of about 20,000 tons of coke per month.

Louisiana

NEW ORLEANS.—Steel rolling mill promoters have enlisted the services of a broker to seek a large site on a public belt railroad and served by water transportation. The promoters have incorporated under the law of Delaware as the Dixie Steel Corporation, with a capital of \$500,000 to utilize high-grade scrap iron.

Maryland

BALTIMORE.—The Crown Cork & Seal Company, Guilford Avenue, will build a new four-story, reinforced-concrete plant at Foster Avenue and Twelfth Street. The structure will be 30 x 125 ft. and will be equipped for the manufacture of bottle stoppers and kindred specialties.

Minnesota

DULUTH.—The Minnesota Steel Corporation will expend two million dollars for construction work. The enlargement of the plant will begin at once, and includes two blast furnaces and four open-hearth furnaces, costing \$1,500,000, plans for which are already under way. Erection of a benzol plant was started some time ago, costing \$500,000, and is expected to be in operation in eight months. A second unit of furnaces will be constructed next year, consisting of six blast furnaces and fourteen open hearth furnaces.

MINNEAPOLIS.—A one-story factory building 100 by 120 ft. is being built at Johnson and Broadway, which will be occupied Aug. 1 by the Columbia Chemical Company to manufacture phosphoric acid, caustic soda and fertilizers.

MINNEAPOLIS.—Coincident with the opening today of the Mississippi River navigation to Minneapolis the Columbia Chemical Company announced it will build a plant here and bring Tennessee phosphate rock by river transportation for treatment. The plant will comprise for the present a brick and steel two-story building on ground 100 by 150 feet and a boiler house 40 by 50 feet. The Austin Company of Cleveland has the contract. C. N. Lockwood is secretary of the new company and George Walker, chemist, is the technical head. The plant will make sodium phosphate, caustic soda, phosphoric acid and sodium sulphate.

Montana

BUTTE.—The selection of a site for a rod and wire mill at the plant of the Boston-Montana Smelter of the Anaconda Company at Great Falls, Mont., is officially announced. The mill will involve an expenditure of \$500,000 and will have a daily capacity, with only one shift working, of 200,000 pounds of copper rods and 65,000 pounds of copper wire.

GREAT FALLS.—Owing to the strike in Butte, the Washoe smelter of the Anaconda Copper Mining Co. has closed, and the Great Falls smelter has curtailed production. Plant here is out of copper concentrates, and copper refinery is also short. Labor trouble in Butte is reflected by the decrease from 20,000,000 to 8,000,000 pounds of copper for the June output.

HELENA.—Representatives of Pennsylvania steel mills are now in Granite County looking over the ground with a view to erecting a large smelter for the reduction of manganese ore.

HELENA.—Employees of the East Helena smelter of the American Smelting & Refining Company were notified recently of a voluntary increase in pay of 25c. per day, to prevail as long as the sale price of lead is \$11 a hundred weight or more.

KELLOGG.—The Bunker Hill & Sullivan Mining & Concentrating Company's big smelter is almost ready for complete operation. Roasters are taking ore, and the furnaces will be blown in within 10 days. The first of the clintering machines has been adjusted and the other four machines will be put in operation. Ore for the first blast will be supplied by the Bunker Hill & Sullivan mine, which made the erection of the smelter possible. The Hecla Mining Company at Burke, Idaho, will become one of the large contributors.

Nebraska

OMAHA.—The United Oil & Refining Company has commenced operations on its 25,000-acre lease in Madill Field, Bryan County. Mr. C. J. Bowman, formerly vice-president of the Southern Oil & Gas Company of Tulsa, is president.

New Jersey

JERSEY CITY.—The American Can Company, 120 Broadway, New York, is reported to be negotiating with the local Chamber of Commerce for a site in the Fairmount Terminal section for the construction of a new plant, to cost about \$500,000.

JERSEY CITY.—The Interstate Chemical Company will build a one-story addition to its plant on Garfield Avenue, near Marcus Street.

JERSEY CITY.—The Natural Products & Refining Company, manufacturer of refined oils, etc., will build a new one-story plant at Jane and Commercial Streets.

NEW HOPE.—The Union Paper Bag Company is building an addition to its plant.

NEWARK.—The Balbach Smelting & Refining Company, Avenue R and Doremus Avenue, has filed plans for the construction of two one-story additions to its plant, 49 x 100 ft. and 29 x 90 ft., respectively.

NEWARK.—The Nicklesburg Brothers Company will build a one-story shop addition, 34 x 40 ft., to its leather manufacturing plant on Meadow Street.

NEWARK.—The Hanson & Van Winkle Company, 269 Oliver Street, manufacturer of chemicals, etc., will build a new two-story plant, 46 x 50 ft., on Adams Street, to cost about \$15,000.

PARLIN.—The T. A. Gillespie Company has acquired about 640 acres of property in the vicinity of its powder plants at Parlin and Runyon, and is reported to be planning for the construction of extensive additions to provide for increased capacity.

PATERSON.—The East Jersey Pipe Corporation, East Thirty-sixth Street, is remodeling and improving its works to provide for the manufacture of shells. New machinery is being installed. It is planned to commence operations early in August.

PERTH AMBOY.—The General Bakelite Company, manufacturer of insulation specialties, has commenced the erection of a five-story addition to its plant, about 50 x 80 ft., to be used for increased capacity. The company is a subsidiary of the Roessler & Hasslacher Chemical Company, Fayette Street, Perth Amboy.

ROCKAWAY.—The New York & New Jersey Chemical Company has been organized to take over the former plant of the Lincoln Architectural Iron Company, and equip and operate the works for the manufacture of chemicals.

New York

BUFFALO.—The plant of the Buffalo Copper & Brass Rolling Mill Company, 446 Military Road, has recently been acquired by the American Brass Company. The works, which have been used for the manufacture of rolled copper and brass, will be operated at full capacity.

BUFFALO.—The Sizer Forge Company, 238 Larkin Street, manufacturer of steel forgings, is planning to lease property over the Mill Race Strip for extensions to its plant.

FARMINGDALE.—L. I.—The Farmingdale Chemical Company has purchased the former plant of the E. C. Nelson Manufacturing Company, to be used for the manufacture of chemicals.

LONG ISLAND CITY.—The Oakes Manufacturing Company, foot of Blackwell Street, manufacturer of dyewood specialties, will build two reinforced-concrete additions to its plant, to consist of a three-story building, 30 x 100 ft., and a two-story structure, 60 x 80 ft.

POUGHKEEPSIE.—Negotiations were concluded recently looking toward the establishment of the Reliance Aniline Chemical Company of Brooklyn in the vacant factory of the Standard Concrete Construction Company.

SYRACUSE.—The Syracuse Malleable Iron Works, North Geddes Street, specializing in the manufacture of metal wheels for motor trucks, is planning to increase the plant capacity from 25 to 40 sets of wheels daily.

TOTTENVILLE.—S. I.—The Tottenville Copper Company has filed plans for the erection of a two-story addition to its plant on Bethel Avenue.

WATERVLIET.—The Ludlum Steel & Spring Company, Fifth Street, manufacturer of crucible cast steel specialties, is planning for the erection of a two-story addition to its plant on Spring Street.

Ohio

CLEVELAND.—The Clarke - Kessler Chemical Works has purchased from a Cleveland syndicate 17 acres between the

New York Central tracks and St. Clair Avenue and east of Lloyd Road in Wickliffe for a consideration of about \$25,500. The first unit of a chemical plant which will cost about \$30,000 has been started.

COLUMBUS.—Work will start soon on the modern factory sheds which are to be built on Bonham Avenue at the plant of the General Chemical Co., to cost about \$100,000.

PORPSMOUTH.—The William R. Pollock Co. will soon complete a blast furnace for the Whitaker-Glessner Co., after which resources of the concern will be devoted to building a furnace for the Tate Iron & Steel Co. of Sakchi, India.

Pennsylvania

BETHLEHEM.—The Bethlehem Steel Company has awarded a contract for the construction of a one-story, brick and steel addition, 60 x 120 ft., at its Sparrows Point, Md., plant, to be used as a copper shop. The Singer-Pentz Company, Baltimore, has the building contract.

COLUMBIA.—The Keeley Stove Company, Second and Maple Streets, is planning to increase its capital from \$200,000 to \$300,000 for extensions.

FAYETTE CITY.—The Pittsburgh Steel Products Company announced recently new plants and a new town and involving an expenditure of more than \$3,000,000. The extensions will be located in Allen Township, Washington County, on the Monongahela River. The land was purchased last fall and work has already begun.

LANSDALE.—Fire recently destroyed the plant of the Lansdale Rope Works, with loss of about \$20,000. It is said that the plant will be rebuilt. The Barrows Manufacturing Company, Lansdale, operates this property.

MARIETTA.—The National Casting Company is making rapid progress in improving and extending the former plant of the Marietta Manufacturing Company, recently acquired, for the production of iron and steel castings. J. H. Foreman is head of the company.

PHILADELPHIA.—Barclay White & Co. and H. E. Baton are estimating on plans for alterations and additions to the plant of the Surpass Leather Company, at Ninth and Westmoreland Streets.

PHILADELPHIA.—Charles Lennig & Co., manufacturers of chemicals, are building a two-story addition to their plant on Richmond Street, to cost about \$11,000.

PHILADELPHIA.—The Philadelphia Drying Machine Company, Westmoreland Avenue, has awarded contracts for the erection of a new plant at Westmoreland Avenue and Stockley Street, to cost \$40,000. The new site will be used as the main plant of the company, which specializes in the manufacture of drying machinery, allowing for the removal from its present Germantown works.

PITTSBURGH.—The Cunningham Glass Works properties on the south side is under option to the Jones & Laughlin Steel Company for a price of about \$200,000. The property consists of the old glass factory on a lot measuring 360 x 120 feet at Mary and South Twenty-sixth Streets, and two large vacant lots, measuring 252 x 120 feet and 264 x 120 feet on Jane and South Twenty-sixth Streets.

PITTSBURGH.—The Jones & Laughlin Steel Company, Third Street, is said to have acquired an option for the purchase of the plant of the Cunningham Glass Works, Mary Avenue, for about \$200,000. It is said that the plant will be used for extensions.

READING.—The Reading Malleable Iron & Steel Company is reported to be planning for the erection of a new plant at Norristown.

Tennessee

CHATTANOOGA.—Actual manufacture of ferroalloys will probably begin in October at the old plant of the Southern Steel Works in Chattanooga, which has been taken over by the Southern Ferro-Alloy Co. Hydroelectric power will be obtained from the Tennessee Power Co., 3000 hp. having been contracted for. The first product of the new company will probably be ferrosilicon, 50 per cent or higher. The plant of the old steel company is fairly well adapted to the new purpose, but three months will be necessary for its remodeling and for the installation of machinery, which was designed by the Fitzgerald Laboratories, of Niagara Falls, N. Y.

CHATTANOOGA.—The Tennessee Paper Company, recently organized with capital of \$200,000, is planning for the construction of a local plant with capacity of about 50

tons daily. The mill is estimated to cost \$150,000. A. M. Shepherd is head of the company.

Texas

HOUSTON.—The contract has just been awarded by Swift & Co. of Chicago for the construction of a cottonseed oil refinery here to cost \$250,000. It is stated that a specialty will be made of converting cottonseed oil into a lard substitute and other cooking materials. The buildings will be of fireproof brick and concrete construction.

HOUSTON.—R. S. Sterling, president of the Humble Oil & Refining Company, which was chartered recently at Austin with a capital stock of \$4,000,000, stated that they will build a refinery with a capacity of at least 3000 barrels of crude daily at Fort Worth, which will be started as soon as the material can be assembled.

Virginia

GOSHEN.—The Southeastern Iron Corporation, Tower Building, Chicago, recently organized with a capital of \$500,000, is reported to be planning to take over the plans of the Goshen Iron Company and the Victoria Iron Company. It is proposed to remodel and improve the works to provide a total capacity of 200 tons daily. The extension is estimated to cost \$150,000. Francis H. Hardy is president.

Washington

CHEWELAH.—Handy & Chippendale, who have leased the Double Eagle mining properties near this city, will erect three calcine kilns in the development of the magnesite property.

COLVILLE.—The Crown Willamette Paper Company of Portland, Ore., will develop its dolomite properties near here, the dolomite to replace magnesite in paper making. Field kilns for calcining the dolomite will be installed.

KELLER.—The Manila Copper Mining & Smelting Company, Keller, Wash., has been organized, and will operate a 200-ton smelter in Keller. A smelter at that point, built nine years ago, but never blown in, will form the basis of the plant. Plant has copper stack with 150 tons capacity; lead stack of 50 tons; electric power plant, sampling room and laboratory. Considerable new equipment will be added, and the plant put in operation to handle commercial ores.

NORTHPORT.—The Electric Point Mine has opened up a vein of solid high grade lead carbonates in a body 59 ft. wide. Property is to be developed on a large scale.

NORTHPORT.—The Northport Smelter here, at a cost of \$100,000, is putting in a Cottrell plant for the saving of values in the smelter smoke. The smelter has been losing \$600 a day through its smoke, and it is claimed this plant will pay for itself in six months.

NORTH YAKIMA.—The Utah Idaho Beet Sugar Company's plant at North Yakima is nearing completion. It will have a capacity of 500 tons of beets per 24-hour day and it is estimated to cost \$400,000 to \$500,000. A novel feature in the equipment being installed is a pulp dryer which, so far as the Utah Idaho company is concerned, is a new departure.

NORTH YAKIMA.—Harry V. Saint, secretary of the Commercial Club, states that according to a telegram from Eastern interests, a potato starch factory will be erected in the near future in the city.

POR ANGELES.—A plant will be established in this city by the Washington Pulp & Paper Company for the extraction of tannin from hemlock bark for use in the tanning industry. Plant will have capacity of 24 cords of bark daily.

SEATTLE.—The Charles A. Newhall Company, chemical and inspection engineers, Seattle, has received contract for inspection of a large order of creosoted timber and creosoted piling, work to be done under U. S. Engineer's Office, Major E. J. Dent. The Newhall Company is associated with the Pittsburgh Testing Laboratory.

SEATTLE.—The Hurley-Mason Company, Hoge Building, has received contract for construction of coal bunkers and 60 beehive coke ovens at Croker for the Carbon Hill Coal Company.

SEATTLE.—The Pacific Coast Steel Company, headed by William Pigott, has purchased the plant of the Oregon Steel & Iron Works at Owego, Ore., and will put the plant in operation for the manufacture of pig iron, using ores from the west coast of South America. The plant cost \$300,000 and was built twenty-five years ago. It has

been idle a large part of the time. The Pacific Coast Steel Company also announces the merger of the Seattle Car & Foundry Company of Seattle with the railway car-building plant of Twohy Bros., of Portland and Spokane, under the name of the Pacific Car & Foundry Company. William Pigott is president of the new concern. The company recently purchased and is putting in operation the Irondale plant of the Western Steel Corporation, where blast furnaces are being installed. An extensive program of car building, pig iron manufacture and industrial development is planned by the new corporation.

SPOKANE.—The United Copper Mining Company, according to Conrad Wolfe, president, will immediately double the capacity of its concentrating plant. The plant will have increased capacity of 600 tons daily. New equipment to be installed will include tube mill, 10 tables and classifiers.

SPOKANE.—The American Fire Brick Company's branch plant will be established here at once. An old brick plant has been taken over by President-Manager C. P. Oudin, and will be converted into a plant for manufacture of calcined magnesite, magnesite brick and other magnesite products. All of the machinery in the plant will be scrapped, and new equipment, costing \$25,000, will be installed.

SPOKANE.—The Giant Ledge Mining Company, operating large mining properties in the Coeur d'Alenes, plans the installation of a 150-ton mill, which will later be enlarged to twice that capacity.

West Virginia

BELLE.—A deal was closed recently by New York interests for the Slack Farm at Belle, a town 12 miles east of Charleston, on the Kanawha and Michigan side of the river, on which property they propose to construct a million dollar electrical refining plant to refine high-grade chemicals and by-products from other factories now located in the Kanawha district.

MOUNDSVILLE.—W. H. McSwain and associates have organized a company to operate a local plant for the manufacture of glass rolling machinery.

SISTERVILLE.—The Independent Glass Company is making extensive repairs to its plant which will make it almost like a new plant when it is completed. New tanks and two new ovens are being placed in the plant and the stack has been raised 35 ft. and four new sections of roof have been put in place. Five gas producers will be installed and two 50-horsepower boilers will be added.

WHEELING.—The Wheeling Chemical Products Company, 3102 Jacob Street, has been manufacturing matches, glue and other chemical products since the first of the year and promises to be one of the large match factories of the world.

WHEELING.—The Wheeling Mold & Foundry Company, manufacturer of iron and steel castings, is planning for the operation of its plant at maximum capacity for the production of battleship armament. It is said that the works will be devoted to this specialty for the next twenty-four months.

WIERTON.—The Phillips Sheet & Tin Plate Company, specializing in the manufacture of cold rolled strip steel and tin plate, is planning for the construction of additions to its plant to increase the present output.

Alaska

CORDOVA.—About 200 mines in the Bonanza and Jumbo Mine, the property of the Kennecott Copper Corporation, have struck for wage increases of from 15 to 50 per cent, depending on market price of copper. About half of the crew is at work.

SEWARD.—The Seward Brick & Tile Company has leased a site in this city and will establish a brick and tile manufacturing plant. Large deposits of the finest pottery clay have been tested and found available.

SEWARD.—The big mill of the Alaska Juneau Mining Company, now operating four units, or about one-third of its maximum capacity, will have all twelve of its units in operation within thirty days. About 100 men will be employed.

SEWARD.—William Martin, here, announces that on account of the high cost of cyanide he will not operate the cyanide plant this season, but has installed a centrifugal amalgamator which will remove the gold from the slimes.

British Columbia

FERNIE.—Coke has started to move from the Crow's Nest Pass collieries, and four furnaces of the Grand Forks smelter

of the Granby Consolidated & Mining Company will be blown in shortly. Production is 60 per cent normal, and in the near future 400 tons of coke will be turned out daily from the ovens at Fernie. The two-months strike has been terminated, and most of the men are back at work.

TRAIL.—About 40 tons daily is the average output of the electrolytic zinc smelter of the Consolidated Mining & Smelting Company. The first story of the No. 4 greater plant, requiring 150,000 brick, is practically finished, and steel is being erected.

TRAIL.—The Trail smelter of the Consolidated Mining & Smelter Company, according to a report recently issued, received 3852 tons of ore in the seven days ending June 14, as compared with 2749 tons in the last previous seven days. The mine which made the greatest number of tons shipment to the Trail smelter for the year is the Sullivan Mine at Kimberley, which is unaffected by the coal strike. Its total to date is 61,452 tons. The output is zinc ore, which is treated at the Consolidated company's electrolytic plant at Trail, and requires no coke for smelting.

VANCOUVER.—As a result of the Crow's Nest Pass coal strike, the metalliferous mining industry in the Kootenays is at a standstill, there being at present an extreme shortage of coke.

Manufacturers' Notes

JAPANESE INDUSTRIAL ACTIVITY IN MANCHURIA.—The Government General of Kwantung and the authorities of the Manchuria Railway Company are taking steps to develop industries in the railway zone, and especially in and about Dairen, according to Commerce Reports. They have been making investigations with special reference to the manufacture of oil from Manchurian beans and of soda from Kwantung salt, as well as the zinc-refining and iron-refining industries. The railway company already has acquired the right to exploit a Chinese iron mine, and it is expected that operations will be started before the end of the year. It is now reported that the authorities have nearly completed arrangements for undertaking the soda industry. What shape the project will assume is not yet definitely known, but according to one report, it will be undertaken by the Dai Nippon Engyo Kaisha, which has the sole right of importing Kwantung salt into Japan proper, with the financial assistance of the Manchuria Railway Company. Messrs. Suzuki & Co., and the Mitsui Bussan Kaisha; and according to another report a separate joint stock company with \$4,985,000 capital will be established for the purpose.

It is understood that the authorities are in communication with Suzuki & Co. and other capitalists interested, and that the project will soon materialize. It will have the advantage over similar undertakings in Japan proper of getting supplies of Kwantung salt at less than 7½ cents per 100 lb., as against 24½ cents paid at home. With this cheap supply of material, it is hoped that the new company will be able to compete with British and German rivals successfully, even after the conclusion of the war.

It is said that a project for the manufacture of bean oil also is maturing. Apart from these official or semi-official undertakings, there have been increased private undertakings for spinning and weaving recently in the zone of the South Manchuria Railway Company.

AMERICAN CHEMICAL COMPANY TO OPERATE IN BRAZIL.—The American Chemical Works (Inc.), with headquarters in Wilmington, Del., has been authorized by the President of Brazil to operate in the Republic, according to Commerce Reports. The capital of the company is said to be \$50,000, and the amount set aside for operations in Brazil \$10,000.

A. H. NEY, INC., consulting chemists and chemical engineers, have taken over from Moses, Pope & Messer, the chemical laboratories hitherto occupied by the latter at 76½ Pine Street, New York. Mr. J. M. F. Leaper, vice-president of the company, is in charge as director of the laboratory.

THE ASBESTOS PROTECTED METAL COMPANY of Pittsburgh announces the temporary closing of its Cincinnati Office on August 1, 1917, due to the fact that Mr. E. G. Irwin, Cincinnati manager, has entered the Ohio national guard. Communications addressed to the home office, First National Bank Building, Pittsburgh, will receive immediate attention.

THE LACKLAND-PAYNE REFRACTORIES COMPANY, composed of Henry K. Lackland and James K. Payne, announced the opening of their office at 1603

Boatmen's Bank Building, St. Louis, Mo. The company is in a position to make prompt shipment of firebrick and clay.

AMERICAN CATALOGUES WANTED.—The American Chamber of Commerce for Italy, located at Via Victor Hugo No. 4, Milan, desires to secure catalogues and price lists from American firms relating to all kinds of goods. This organization, which was formed over two years ago, now has a membership of over 500 and is doing a great work in promoting trade relations between the United States. Recently it has established a trade catalogue library and desires to make it more complete. It is in possession of many catalogues, but desires to secure duplicates. For this reason firms that have already sent one copy are requested to send another, and other firms are asked to forward them in duplicate. In addition to the catalogue library, the chamber possesses a library containing books on trade information. It solicits contributions in this line also.

BROMINE AND CALCIUM CHLORIDE.—According to figures recently compiled by R. W. Stone, of the United States Geological Survey, the quantity of domestic bromine marketed in the United States in 1916 was 688,260 lb., valued at \$922,225. This quantity includes only elemental bromine made from natural brines pumped in Michigan, Ohio, and West Virginia; it does not include bromides, the salts of bromine that are widely used in photography and medicine. The production reported in 1915 was 855,857 lb.

Bromine is used instead of chlorine as an oxidizer in many chemical reactions, and for dissolving gold and separating it from platinum and silver; it is also used in disinfectants, drugs, and photographic chemicals, and in making aniline colors. Recently it has been extensively used in making the asphyxiating gases employed in the European war.

The quantity of calcium chloride made from brine and sold in the United States in 1916 was 26,062 short tons, valued at \$216,729, an increase of 22 per cent in quantity and 65.7 per cent in value over the production of 1915. This quantity does not include calcium chloride obtained in the manufacture of soda, as calcium chloride so obtained is not an original constituent of the brine.

Calcium chloride is made from natural brines at Mount Pleasant and Saginaw, Mich.; Pomeroy, Ohio, and Mason, Hartford and Malden, W. Va. As the same brines yield salt and bromine, practically every constituent of them is turned to profit. Calcium chloride is used as the circulating fluid in refrigerating plants, in cement concrete, and in automobile gasoline water jackets to prevent freezing, and for laying dust on roads, drying gases, vegetables, and fruits, and dehydrating organic liquids. Calcium chloride in solution is especially valuable in automatic-sprinkler systems and in fire buckets.

LARGE INCREASE IN SALT USED BY CHEMICAL WORKS.—The domestic consumption of salt in 1916 was 45,720,860 barrels of 280 lb. each, an increase of more than 7,000,000 barrels over the consumption of 1915. According to statistics compiled under the direction of R. W. Stone, of the United States Geological Survey, the domestic production of salt in 1916 was 45,449,329 barrels, the imports were 871,992 barrels, and the exports 600,461 barrels. This was an increase of 19 per cent in the quantity of salt produced. The total value of the salt was \$13,645,947.

Michigan, as usual, was the largest producer, and New York was a close second. The production, in barrels, by the leading States was as follows: Michigan, 14,918,778; New York, 14,087,750; Ohio, 6,706,193; Kansas, 4,564,793; California, 1,124,236.

Perhaps the most marked feature in the salt industry in 1916 was the great increase in quantity of brine sold as such or used by chemical works, the increase being 37 per cent and the total production over 18,000,000 barrels. The production of rock salt increased over 17 per cent and amounted to 9,973,950 barrels, valued at \$2,665,270. On the other hand, the production of evaporated salt increased only 5 per cent, to 17,575,629 barrels, but the value was \$10,149,412, an increase of nearly 15 per cent.

FELDSPAR PRODUCED IN 1916.—The production of feldspar in the United States in 1916, as reported to the United States Geological Survey, was 118,465 long tons, having a value as crude material, f.o.b. mines, of \$404,689. Of this amount 75,165 long tons entered the market as crude feldspar, valued at \$251,372, and 48,496 short tons were ground by the producers and sold for \$450,906. During the year the price of crude spar averaged about \$3 per long ton and of ground spar about \$9.30. Feldspar

was mined in the following States, named in order of quantity produced by each: North Carolina, Maine, Maryland, New York, Connecticut, Pennsylvania, Georgia, Virginia, California, New Hampshire, Vermont. The output came chiefly from 50 quarries, but a like number of small or intermittently worked deposits contributed materially to the total.

Feldspar is used mostly in the pottery and enameling industries, which consumed 82 per cent of the year's output. Probably less than 1, 2, and 3 per cent, respectively, of the total output were used for chicken grits, soap, and other abrasive purposes, and in making glass. Roofing and cement surfacing consumed about 7 per cent and an equal proportion was used in preparing fertilizers and in the experimental extraction of potash.

DISTRIBUTION OF ITALIAN SULPHUR SUPPLIES.—An announcement has been made, according to Commerce Reports, by the Minister of Munitions that in connection with the distribution of Sicilian sulphur the Italian Government has allotted certain specified quantities to each of the Allied Governments, and accordingly the British Government will purchase hereafter directly from the Italian Government the quantity allotted to Great Britain. The distribution in England thereupon will be undertaken by the Ministry of Munitions. A committee has been appointed to deal with the matter and it has decided to offer to supply imported sulphur in lots of not less than 5 tons for use in approved trades and industries. The prices per ton for the present will be: Flowers of sulphur, \$112; roll brimstone, \$102; thirds, \$60.83, including delivery to the purchaser's nearest railway station.

From the prices mentioned above a discount of 2½ per cent will be allowed to recognized sulphur merchants and dealers, but not to consumers. Applicants claiming this discount must furnish satisfactory evidence that they were recognized sulphur merchants or dealers before the war.

The committee understands that "recovered" sulphur can be procured, in the ordinary way of business, from the home producers.

Manufacturers' Catalogs

FALKENBURG & LAUCKS, Seattle, Wash., has issued a booklet on "Ore Testing Schedules," dealing with different tests.

THE HOSKINS MANUFACTURING COMPANY, Detroit, Mich., has issued Bulletin 3-A, June, 1917, describing Hoskins pyrometers.

THE ECONOMY FURNACE APPLIANCE COMPANY, Chicago, Ill., has issued a pamphlet on "Stop Making Smoke."

THE LINK-BELT COMPANY, Chicago, Ill., has issued an interesting booklet on "The Ideal Drive for Textile Machinery."

THE GENERAL FILTRATION COMPANY, Inc., Rochester, N. Y., has issued a booklet on "Filtros," describing physical and chemical properties, shapes and sizes, grades, uses, electro-filtros, installations, containers and care of filtros.

SAUVEUR & BOYLSTON, Cambridge, Mass., has issued a pamphlet on "Photomicrographic Apparatus" describing and illustrating their different instruments.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., has issued Bulletin 34-Y on "Gas Gasoline Driven Air Compressor."

THORDARDSON ELECTRIC MANUFACTURING COMPANY has issued sheets on their transformers, wireless and low-voltage, jump spark coils and make and break coils.

D. R. SPERRY & CO., Batavia, Ill., has issued an attractive catalog on the Sperry Filter Press with illustrations.

Other New Publications

SAND-LIME BRICK IN 1916. By Jefferson Middleton. A Department of the Interior publication issued May 31, 1917.

PROPERTIES OF THE CALCIUM SILICATES AND CALCIUM ALUMINATE OCCURRING IN NORMAL PORTLAND CEMENT. By P. H. Bates and A. A. Klein. A Department of Commerce publication No. 78, issued June 9, 1917.

THE VALUE OF PEAT FUEL FOR THE GENERATION OF STEAM. By John Blizzard. Issued by the Canadian Department of Mines, Ottawa.